# AN INTRODUCTION TO AGRICULTURE

A. A. UPHAM

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# AN INTRODUCTION TO
# AGRICULTURE

# AN INTRODUCTION

TO

# AGRICULTURE

BY

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# PREFACE

The author's thought in preparing this book has been to provide an elementary text on agriculture suitable for use by children of the seventh and eighth grades, and by pupils of a corresponding advancement in ungraded schools. It is hoped, also, that the book will not be found unsuited to the needs of Reading Circles and of individual students.

The author, of course, makes no claim to completeness, nor is the book offered as a guide to farming. The effort has been, however, to touch those matters which would be most useful to pupils in our rural schools, and especially to give the underlying theory for many farm processes and practices.

It is believed that teachers and students will find the summaries and questions at the end of each chapter especially helpful in reviewing and making definite the information which the chapters contain. One of the most important reasons for teaching agriculture in schools is to prepare pupils to read and understand



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agricultural literature. Lists of such literature and directions for obtaining it will be found at the end of the book.

Acknowledgment is gratefully made for the use of material found in various Farmers' Bulletins and reports, especially those of the United States Department of Agriculture, and of the State Experiment Stations of Wisconsin, Vermont, and Minnesota. The author is grateful to Superintendent O. J. Kern, of Winnebago County, Illinois, for the use of the illustrations on page 155, and also to others whose names appear in connection with various illustrations for the use of the same.

A. A. Upham.

Whitewater, Wis., 1910.

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# AN INTRODUCTION TO AGRICULTURE

## CHAPTER I

### THE NATURE OF PLANTS

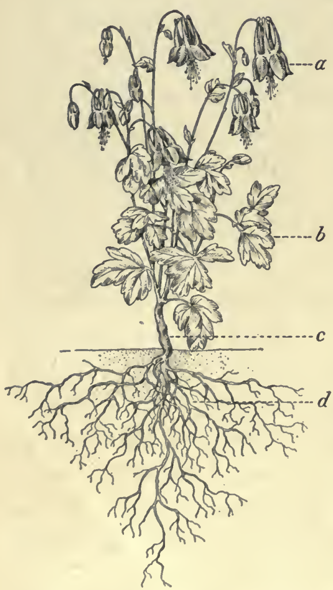
1. **The Science of Agriculture.**—Agriculture or farming consists primarily in raising plants and animals. The farmer aiming to have a profitable business must understand many things about the plants and animals he raises, for without a knowledge of their nature, their habits, and their needs he may labor year after year making only a halfway success of his work. It is easy to waste the good things that Nature has provided for the farmer. It is easy also to increase greatly the ordinary production from the land—if one only knows how.

How to get the best results in agriculture is a question that men are studying all the time. Agriculture is a science—one of the most useful of all the sciences. Wherever agricultural science improves farming it benefits mankind. Human beings everywhere are dependent on farming for food. This food in great variety comes from plants and from animals. Animals themselves are dependent on plant growths for food. So we see that the growing of plants by farmers is one of the fundamental occupations of human kind.

The farmer, first of all, should be interested in studying the fundamental facts of his science. He must

understand how plants grow and what kinds of soil are best suited to the growth of the various plants. He must have a scientific knowledge of the diseases and the enemies of plants and how to overcome them. He will wish to know also many facts about cattle, poultry, sheep, and other farm animals. Such fundamental facts we are to study in this book.

2. **The Parts of a Plant.**—In speaking of plants now we are thinking of all kinds of things growing out of the earth that provide food—trees, grains, grasses, vines, roots, and all the others. Most plants have roots, stems, leaves, flowers, and fruits or seeds. Some of the lower plants, which are used for food, such as mushrooms, do not have all of these parts. Some are dependent on other plants for their support and for their nourishment. These parts or organs are concerned with the two functions of plants—growth and reproduction. The growth organs are the roots, stem, and leaves; the reproductive organs are the flowers, fruits, and seeds.



Typical Plant (Columbine). Showing *a*, flower; *b*, leaf; *c*, stem; *d*, roots.

*Roots.*—The roots reach out through the soil, holding the plant in place and gathering food for it. They

arise from the stem, and branch or divide into smaller roots, until they become fine, delicate rootlets. Except at their tips, the tiny rootlets are covered with still finer root hairs. These root hairs take in food for the plant. They may increase the absorptive or feeding surface of the root seven to seventy-five times.

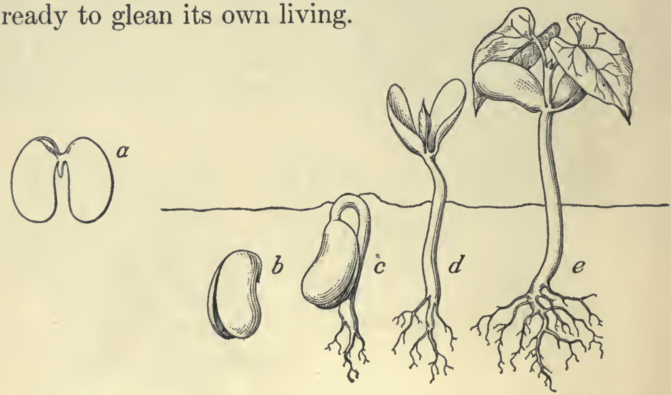
*Stems and Leaves.*—The stem is the supporting organ, the framework on which the leaves and flowers are borne. It may be very short and thick as the "crown" of turnips and beets; it may be very slender and light as in the grains and grasses; or it may be large and strong


GOOSEBERRY. Showing *a*, flower; *b*, fruit; *c*, seeds.

as in the trunks of trees. The food absorbed by the root hairs passes through the larger roots and the stem to all parts of the plant. On the stem and generally in the axil of a leaf, *buds* are borne which produce branches bearing either leaves or flowers. The leaves help gather food by absorbing gases from the air. And it is in the leaves that the food elements gathered by the roots and leaves are made ready for the use of the plant.

Place the stem of a plant (balsam) in water colored with red ink and watch the passage of the water up the stem and into the leaves.

*Flowers, Fruits, and Seeds.*—The flowers on a plant produce the fruit and seeds. The seed, as you know, contains the young plant. The parent plant stores food in the seed, and this food the young plant uses in sending out its first shoots and getting ready to glean its own living.




LIMA BEAN. *a*, cotyledons opened to show hypocotyl and plumule *b* to *e*, successive stages in germination showing development of hypocotyl, roots, cotyledons, stem, and plumule.

**3. How a Plant Grows.**—You may have seen how a plant begins to grow from the seed. It sends a shoot upward toward the light and another shoot downward as a root. The upward shoot becomes the stem. It branches out and has leaves, and so makes the full-grown plant which we see. The root, as it grows, also divides into many branches which run through the ground.

If you put some beans or other large seeds in water or damp sand, you can see how they sprout. On the outside will be found two coatings. Beneath these are two leaves, thick and yellow. They contain the nourishment on which the young plant begins its life. These leaves are called *cotyledons.*

Place some large seeds, such as beans or peas, in water over night. Then take out some of them and study their structure. Place the others in damp sawdust or sand. Continue for several days the study of the little plants.

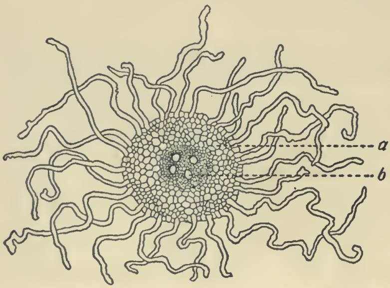
Lay the first leaves apart and you will find between them two tiny leaves supported by a minute stem. These inner leaves are called the *plumule* and the stem is called the *hypocotyl.* The hypocotyl grows and lifts the leaves above the ground. From the hypocotyl also the first root starts in its downward growth. In some plants the plumule develops into the first real leaves; in others the cotyledons become the first leaves above ground. Corn and certain other seeds have only one cotyledon.

4. **How the Plant Gets Its Food.**—The plant starts its life by feeding on the food stored in the seed. But as soon as its leaves have reached the sunlight and its roots begin to spread out through the soil, the plant must find and make its own food. Air, water, and mineral salts in the soil are the plant's food materials.

Sprout grains of corn, wheat, barley, etc., between two pieces of damp cloth inclosed between two plates. Place two or three matches with the seeds to prevent mold, and set the plates in a warm place. In a few days study the seedlings, ex-

amining the parts. Notice the hairs on the roots. Compare the different kinds of plants.

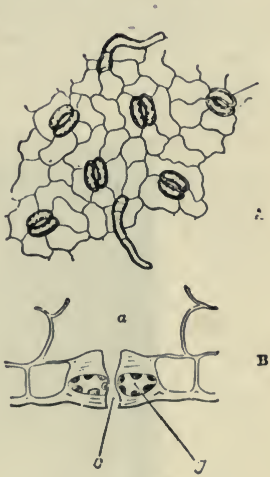
The plant can take in nothing in solid form. All its food from the soil comes to it dissolved in water, which can pass readily from the soil through the root hairs into the tiny rootlets. The soil water contains carbonic acid derived principally from decaying organic matter which helps it to dissolve the mineral compounds in the soil. The water passing into the root hairs takes with it the mineral salts that are necessary to the plant's health and growth. These mineral salts are really several substances mixed together, but all are called salts. While the salts are dissolved in water, we cannot see them. Their tiny invisible particles are mixed with the particles of water in what is known as a solution. If we boil some water until it has all evaporated, we shall generally find in the bottom of the kettle a white substance that looks like common salt. This is the mineral salt which was in the water but which did not evaporate with it. When we burn plants the mineral parts are left in the form of ashes.



CROSS SECTION OF A ROOT SHOWING THE ROOT HAIRS. *a*, bark cells; *b*, duct for passage of water and air.

The plant feeds from the air as well as from the water in the soil. Its leaves absorb gases from the air, and these gases, especially the carbon dioxide, are used

in preparing the food for the plant. In some way that we do not wholly understand, a plant has the power to combine the water, the mineral substances from the soil, and the gases from the air so as to make food for itself. This can take place only in sunlight. In this process the leaves return to the air through the stomata a gas which we call oxygen and more or less water.




UNDER SIDE OF LEAF. Showing *A*, mouths or stomata for passage of air; *B*, a cross section showing *a*, air space; *s*, stoma; *g*, guard cell which opens and closes the stoma.

**5. Conditions of Growth.**—In order to grow well, the plant must have the proper conditions of heat, water, air, light, and food. Until the weather is warm most plants do not even sprout. Light is very essential to the life of plants; in the dark they stop growing or grow only a little and weakly. A certain amount of water must be in the soil within reach of the plant, or it will wither and die. There must be a free circulation of air, and the proper amount and kinds of plant food must be in the soil.

1. In two flowerpots plant some grains of wheat or oats, after soaking in warm water for several hours. When the seeds have germinated, place one flowerpot where a strong light will reach it from all sides and the other in a window where the light comes from only one side. Watch the results.

2. After a lawn has been mowed, cover a small section of it with a box, bottom upward. The box may be a foot or more

square. After a few days the grass beneath will have lost its green color and ceased to grow. Why?

3. In two wide-mouthed bottles place some damp sawdust. After soaking in water a handful of grains of wheat or oats place half in each bottle. Cork one bottle very tightly, covering it with vaseline, and leave the other open. Watch the results.

*a* *b*

Tobacco Plants. *a*, grown in the light; *b*, grown for two weeks in darkness. *After Errera and Laurent.*

**6. Plant Food Must Be Usable.**—The plant food in the soil must be in such a condition that the plant can use it. Many stones in the field may be full of plant food, but the plant cannot use it in this form. If a stone is broken almost to a powder, even then the elements the plant needs may be combined with something else so that the plant cannot get its food. This food

must be changed and dissolved in water before the plant can use it. It is as if a hungry boy stood outside a locked pantry door. The food is there, but it can do him no good until the door is unlocked. So we say the plant food is locked up.

One thing that helps unlock this food is air in the soil. Among the loose particles of soil there is air as well as water, and the farmer must take care that the air is not shut out. Much of the farmer's work consists in releasing this food so that the plant can get it. How it is done we shall learn later.

## SUMMARY

The plant consists of root, stem, leaves, flowers, and fruits, or seeds.

The food of the plant consists of air, water, and mineral salts.—Food material in the soil is dissolved in water and absorbed by the root hairs of the plant.—Gases from the air are absorbed by the leaves of the plant.

The conditions of plant growth are proper heat, moisture, air, light, and food.

Much of the farmer's work consists in making plant food usable.

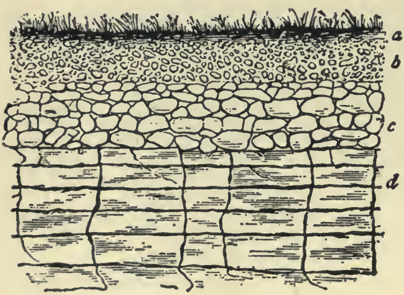
## QUESTIONS

1. Why is agriculture one of the most useful of all the sciences?
2. Name the parts of a plant. Tell the uses of each.
3. Why are root hairs so important?
4. What are the right conditions for germination and growth?
5. Name and give the use of each part of a seed.
6. In what form is plant food usually found in the soil?
7. Why cannot the plant use stones for food?

# CHAPTER II

## THE SOIL

**7. The Composition of Soil.**—By *soil* we mean that part of the earth's crust in which plants grow. It is the loose decomposed layer of mineral matter resulting from rock decay which furnishes food and foothold for plant and animal life. Soil may be from a few inches to several feet in depth. The earthy material beneath the soil is called the *subsoil*. It is generally harder and colder than the surface layer of soil and it is generally not suitable for plant growth.




SOIL FORMED FROM ROCK UNDERNEATH. *a*, soil with grass growing in it; *b*, subsoil, coarser and more rocky; *c*, coarse, loose rock; *d*, rock in layers, cracked. *d* changes to *c*, *c* changes to *b*, and *b* to *a*.

Soil is usually a mixture of decayed rocks, plants, and animal matter. We say that a rock is "decayed" when it crumbles up. You may have seen in a gravel bed stones whose outer surface can be crumbled with the hand. The crumbling of rocks helps to make soil. The

pieces that break off are sometimes small and sometimes large. In many soils there is a gradual grading from the fine soil on top, down through coarser and coarser parts, until rock is reached.

Plants on the surface of the ground wither and die, and gradually become a part of the soil. In some places in the woods the fallen leaves have lain undisturbed for centuries. They have decayed and made a dark-colored substance in the soil. The roots of plants that have died, rot or decay and add other vegetable substances to the soil. These decayed parts of plants give to the soil some material that is very valuable for the growth of plants and improve it in other ways by making it light so that light and water will circulate through it readily, causing it to warm up earlier in the spring. Animal matter also enters into the soil and helps to make fertile soil. The decaying plant and animal matter in the soil is called *humus*.

8. **Kinds of Soil.**—Most soils are made up chiefly of four different grades of materials—sand, silt, clay, and humus. Sand is a coarse-grained material, silt is finer, and clay finer still. Humus has been described above. If the soil consists of these four materials in fairly equal proportions, it is called *loam*. If there is more of one material, the soil is given a corresponding name, as sandy loam, clay loam, etc. If there is much sand, the soil may be called light sandy, or if there is much clay, the soil may be called heavy clay. The terms *heavy* and *light* do not refer to the actual weight of the soil, but to the difficulty in working it because of its stickiness or lack of it. The physical nature of any soil is largely de-

termined by the kind of rock from which it is derived. Some of the more common of these rocks are described below.

Examine the soil in the garden and field and determine whether it is sandy, clayey, or loamy. Examine it where a bank has been cut through and notice the variations as we go down from the surface.

*Granite*, the rock commonly used for monuments and buildings, consists mainly of three minerals mixed together—quartz, feldspar, and mica. When a granite rock decays, the quartz, being hard, remains as sand. The feldspar and the mica are partly dissolved and break up into fine particles, which make *clay*.

*Sandstone* is made of grains of sand cemented together. The sand may be coarse or fine, white or colored.

*Limestone* is a softer stone of many grades and all colors from black to white. It is made of the dust of ground-up shells of clams, oysters, and other sea creatures. The shells, moved back and forth over stones or other shells by the waves, are ground to a fine dust. This dust is worked together into a hard mass and forms rock. Clay and sand washed down by the rivers mingle with the shell dust, and thus the limestone sometimes contains clay and sand also. When limestone decays, much of it is dissolved and carried away, leaving the clay to settle and form a clay soil. Sometimes limestone may contain so much sand that its decay makes a sandy soil.

If possible, obtain specimens of granite, sandstone, and limestone. With a hammer break up a piece of each into frag-

ments as small as peas. Take three bottles half full of water and put into them pieces of the broken stones, free from dust or dirt. Put only one kind of stone in each bottle, and have the pieces about an inch deep on the bottom. Cork the bottles carefully and shake them several times a day for a week. Observe in which bottle there is the greatest accumulation of soil.

**9. Formation of Soil—Rock Weathering.**—The decay of rocks and the making of soil take place chiefly by a process called *weathering*. Let us see how weathering acts on the rocks.

Granite, as we have learned, consists of three minerals cemented together. If one of the minerals is dissolved, the rock will fall to pieces. You may have seen plaster break and fall from the ceiling of a room when water has leaked through from above. The plaster is made of lime and sand, and when the water dissolves the lime, the plaster can no longer hold together. In a similar way, water working on a granite rock may dissolve a little of the feldspar or mica, and then the granite crumbles.

Limestone also crumbles when water dissolves some of the cement that holds it together. If the water working on limestone contains a little acid, the stone decays faster. Water in the ground is nearly always slightly acid.

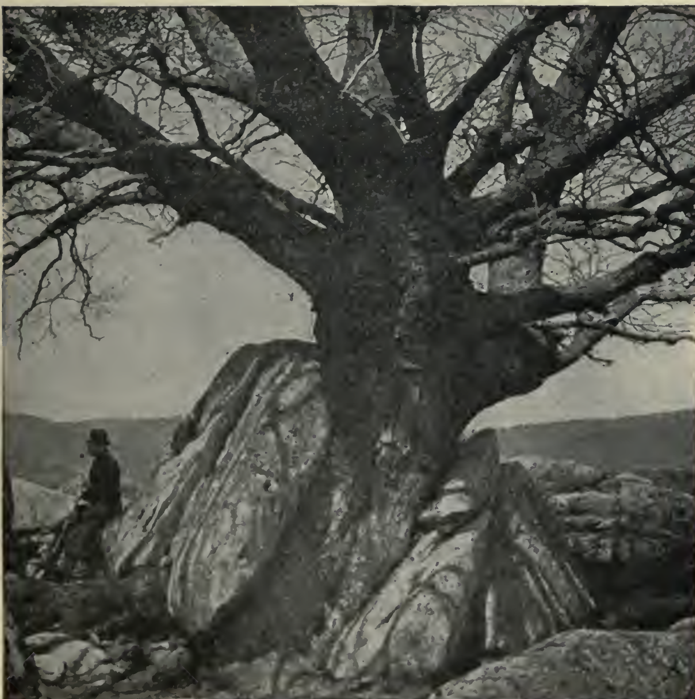
Water sometimes works its way into a rock and freezes there. Now we know that water in freezing expands. If a bottle full of water freezes, the bottle is likely to be broken because of the expansion of the water. In like manner, water freezing in a rock tends to split off a layer of rock.

Sunlight on a rock tends to flake off the outside surface. The heat seems to make the rock expand and crack, just as the top of a stove may crack from the ex-

WEATHERED LIMESTONE.
Wasting is by solution. Water finds readiest access along joints.

pansion caused by heat. When the weather turns colder at night or in the winter, the rock contracts and this helps to make it flake off. The various constituents of which a rock is composed expand differently under the effect of heat, and the many different strains which result break the rock apart. Thus the changes in temperature are constantly working toward the loosening of par-

ticles of rock. In regions where the soil is not protected by vegetation, the wind is an important factor in breaking down rocks. Particles of sand caught up and driven against rock surfaces exert a surprising grinding power. Cliffs and bowlders are undermined in this way.



Rocks Wedged Apart by Growing Tree.
Western Massachusetts.

Sand driven along by a current of water acts in the same way.

Plants also help to decay rocks. There is a class of

plants, called mosses and lichens, that grow on rocks and that dissolve the rock material by acids which they contain. Wherever plant roots come in contact with rock, they act on the rock particles and help to crumble the rock. If they get into the rock crevices and grow they may fill the crevices and force the rock apart. The acid developed in the formation of humus in the soil is another agent in the breaking down of rock.

We see, therefore, that the chief agents that break down rocks are water, acid, heat, and cold, ice and frost, winds, certain plants that grow on rocks, plant roots, and humus. We call these the agents of weathering.

Search a gravel bank for specimens of weathered stones.

If a running brook is near, notice the coarse stones in the middle of the brook and the finer ones nearer the edge. At the very edge, or where the water runs slowly, there may be only mud. After a rain notice the sorting power of water as shown in the road or street.

**10. Glacial Action in Soil Formation.**—Some of the richest soils in America were formed by the action of glaciers many centuries ago. All over the northern part of our country there once passed a glacier several hundred feet thick. This glacier tore up rocks and ground them to bits, and carried and distributed the pieces over a wide area. Thus a great variety of rock materials was mixed together to form the soil.

Such soils are likely to be more fertile than those formed from one kind of rock or from the rocks in one place. They do not wear out so quickly, that is, their material needed for plant growth is not so soon exhausted.

11. **Uses of the Soil to the Plant.**—We are interested in this study of the composition of soils because it is largely from the soil that plants get their sustenance. By understanding how the soil is made, we learn how to get it into the right condition for the growth of plants.

A Mountain Spur Smoothed and Rounded by a Glacier. Glacier Bay, Alaska.

The soil provides the support in which plants are anchored; trees need a great mass of soil to hold them in place. The soil furnishes the water and much of the nourishment that plants need. The soil also helps to give the plant the right amount of heat. It acts as an absorber and storehouse of heat. If the plant's roots

were exposed to the sun and the wind, they would often suffer from too much heat, and as often be too cold. The soil, like a blanket, both keeps heat in and keeps it out.

**12. Good Farm Soil.**—In order that the soil may do its important work properly, it must be in the proper condition. This means that it should not be lumpy or too hard or too loose. It must be made up of the right proportion of sand, clay, and humus. It should not be wet enough to cake or too dry to supply the plants with the needed moisture. It must be rich; that is, it must have plenty of plant food in the condition in which plants can use it. Soil that is neither too hard nor too loose is said to be *mellow*. A fertile soil has all of these conditions just right for the production of good crops.

## SUMMARY

All soil is made from the decay of rocks, plants, and animals. —The principal soil-forming rocks are granite, sandstone, and limestone.—The principal kinds of soil are sandy soil, clayey soil, light sandy and heavy clay soils.—Mixtures of sand, silt, clay, and humus are called loams.

The chief process of soil making is called weathering.—The principal agents of weathering are water, acid, wind, heat and cold, frost and ice, and growing plants.—Another important agent in the formation of soil is the action of glaciers in grinding down rocks.

The soil is necessary to support the plant and to furnish nourishment and water supply. It affords a place where plant food may change its form, and where the heat of the sun may be absorbed and stored.—In order to do this work properly the soil must be in the right condition.

## QUESTIONS AND PROBLEMS

1. Are there gravel banks with many kinds of stones near where you live? If so, they are probably glacial drift.

2. How can you tell granite from sandstone? Granite from limestone? Sandstone from limestone?

3. Which is darker colored, humus or sand?

4. Why is the decay of rocks called weathering?

5. Geologists tell us that when limestone weathers, ninety-six per cent may be dissolved and carried away. How many cubic feet of limestone would make twelve cubic feet of soil?

6. How many square feet are there in an acre? If a farmer plows eight inches deep, how many cubic feet does he move in plowing an acre?

7. What is the chief operation that you have seen farmers perform to get soil into right condition for plant growth? How do you think this helps?

8. Why do farmers call a sandy soil *light*?

9. Would a rock crumble more where the climate is even or where it is changeable?

10. Can you see any reasons why the surface soil is better than the subsoil? Give them.

# CHAPTER III

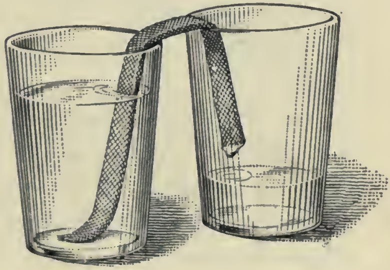
## WATER IN THE SOIL

**13. The Importance of Water to Plants.**—Without plenty of water in the soil, plants cannot thrive. You already know why this is so. Water itself is a plant food, and in the water is dissolved all the other food that a plant takes from the soil. The water must be in contact with the grains of soil so as to get from them the mineral salts needed to feed the plant.

**14. The Movement of Water in the Soil.**—Part of the water that falls during a rain sinks into the soil. Some of it stays near the surface and some goes deep into the subsoil. You know how the water sometimes runs through the soil in a flowerpot and comes out of the hole in the bottom. If the soil is dry, and you give the plant only a little water, none of the water runs out, but all of it is held among the soil grains, which now look moist instead of dry. That which sticks to the particles of soil is called *film water.* That which runs through the soil is called *free water.*

*Evaporation.*—If the flowerpot stands in the sun after it has been watered and the free water has run off, the soil on top will dry out. The water in it has passed off into the air. It has turned to vapor, or, as we say, has *evaporated.*

*Porosity.*—As the soil on top dries, the water in the lower part of the flowerpot gradually moves upward. The film water fills the tiny spaces between the grains of soil. When these spaces in the upper layer of soil are emptied by the passing of the water into the air, more water creeps up from below to fill them. You know how a blotter takes up ink and how a sponge absorbs water. Blotter, sponge, and soil are *porous* objects. Between the particles of which they are made are tiny spaces or pores. Into these pores the liquid moves.



Experiment Showing Capillarity.

*Capillarity.*—The water, we have said, *rises* through the soil. In a lamp wick the oil moves upward from the base of the lamp to the surface where the flame is. Capillarity,[1] or capillary attraction, is the name given to the force which causes any liquid to rise through a porous substance.

Take two glasses; fill one with water, and place them side by side. Place one end of a lamp wick in the glass containing the water, and let the other end hang over into the empty glass. Watch the results.

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[1] Capillary means hairlike. The capillary action of water is best shown in "hairlike" tubes, that is, small glass tubes open at both ends. If such tubes are placed upright in a pan of water, the water will rise in them.

**15. Amount of Water Used by Different Plants.**—The amount of water which plants contain, even when apparently dry, varies from six to eighty-five per cent of their total weight. The quantity of water in some plants, or parts of plants, is shown by the following table:

| | | |
|---|---|---|
| Grains | 10 to 15 | per cent |
| Dry beans | 12.4 | " |
| Green-apple twigs | 50 | " |
| Potatoes | 80 | " |
| Green grass | 85 | " |

But the plant actually needs much more water than is shown by such a table. To keep healthy, a plant must constantly have a great quantity of water passing through its stems or branches to the leaves. The water evaporates from the leaves into the air. Experiments have shown that, for each pound of dry grain to be harvested, three hundred to five hundred pounds of water should pass through the plants producing the grain.

**16. Effect of Too Little Water in the Soil.**—A plant will quickly starve if it has not enough water. Water itself is the most important plant food, and it is the medium for the transmission of plant food, for the plant gets its mineral food in the water which its roots absorb.

Herbs and other plants that have little woody tissue in their stems wilt and droop if they have not sufficient water. The water is needed to fill out the stems and keep the plants stiff and upright, as well as to bring food from the soil.

**17. Effect of Too Much Water.**—Plants may suffer from too much water in the soil as well as from too little.

Air is needed in the soil in order that the plant may get its proper food (Sec. 5). If the soil is very wet, so that water fills all the spaces among the grains of soil, there will be no room for the air. You may understand better how the soil holds both air and water if you think of a wet sponge. The substance of the sponge holds water, and all through the sponge are tiny open spaces, or pores, filled with air.

Too much water may injure the plant in another way. The roots of most plants will not go down into water. If they find the ground too wet, they will spread out near the surface instead of going deeper. Later, when the weather becomes hot, the roots, being near the surface, will dry up. Too much water at first results in too little available water later.

Still another thing we must remember about water-soaked soil. Ground that is very wet is cold. More heat is required to warm water than to warm soil. Then, too, from wet ground water is all the time evaporating. As it passes off into the air, the water takes with it some of the warmth in the ground. This warmth is needed for the growth of plants, and especially of seeds. Rapid evaporation from wet soil wastes it. When the sun is warming the land in spring, wet soil is not made ready for seed planting so soon as soil with only a moderate amount of moisture. A wet soil is likely to be over-acid or sour, and not well suited for crop growth.

Thus we see that for many reasons it is important that the soil for most plants should not be water-soaked. The soil is a storehouse for water. One of the chief problems of the farmer is how to regulate the sup-

ply and give his crops neither too little nor too much water.

For this and some other experiments a small spring balance weighing by ounces up to four pounds is desirable. Provide five pint bottles with the bottoms cut off as follows:

To cut off the bottoms of the bottles, saturate a string with kerosene or alcohol; let it drain and then wind it two or three times around the bottle near the bottom. Tie the string tightly and cut off the ends. Light the kerosene and let it burn, holding the bottle bottom upward. As soon as the kerosene is nearly or quite done burning, dip the bottom of the bottle into water, if the bottom has not already cracked off. Cork the bottles with corks having notches cut in the sides so as to allow water to enter when the necks are immersed in water. Tie a string around the neck of each inverted bottle and bring the string up near the bottom of the bottle so as to make a noose around the bottle. Make a loop in the end of the string into which the hook of the balance may be placed. Weigh each bottle, and record the weight. Place in each bottle a pound (or other known weight) of some kind of soil, as, for example, gravel in one, sand in another, poor soil in the third, loam in the fourth, and leaf mold in the fifth. Stand the bottles bottom up in old tin cans, each can containing the same amount of water. Cover the open ends of the bottles with a piece of rubber sheeting to prevent evaporation. After two or three days weigh each bottle to see which soil has gained the largest amount of water.

Experiment Showing Absorption of Water by Soils.

Empty the remaining water from the cans, replace the bot-

tles, and uncover the ends to allow the water to evaporate from the soil. Note which kind of soil loses water rapidly.

**18. How the Soil May Be Made to Hold More Moisture.**—Let us see what the farmer can do to make the soil hold more moisture. You will remember that water in the soil finds its place in the minute spaces between the particles of soil (Sec. 6); and you have learned that by capillary attraction the water creeps up along the surfaces of these particles of soil (Sec. 14). By breaking up the soil into finer pieces the farmer may increase the total surface and also the total space for the water to fill.

This will be clear if you think of cutting a cube of cheese into pieces. If the cube is one inch square, its surface contains six square inches. By three cuts with a knife the inch cube can be made into eight half-inch cubes. The surface of these eight cubes together is twice that of the inch cube. The inch cube offered no space into which a liquid could be poured, but the eight smaller cubes thrown together offer many little cracks and crevices. This illustrates why the farmer should make his soil fine by tilling, the methods of which we shall study in the next chapter.

EXPERIMENT SHOWING INCREASE OF SURFACE BY SUBDIVISION.

The soil is made more porous and able to hold more moisture, without becoming cold or soggy, by adding humus (Sec. 7) to it. Barnyard manure or plowed-under crops, of which we shall learn in Sections 35 and

36, increase the humus in the soil. Humus can hold more than seven times as much water as the same amount of sand (reckoned by weight) can hold. A little humus mixed with soil increases the ability of the soil to hold water to a degree equal to nearly twice the weight of the humus.

Get three examples of garden soil, one from a depth of six inches, one from a depth of twelve inches, and one from a depth of eighteen inches. Weigh as accurately as possible eight ounces of each and thoroughly dry each sample in a warm place. Weigh each dried sample. Divide the loss in weight by the original weight, to find the percentage of water that each contained.

**19. The Benefits of Underdrainage.**—The best way to regulate the amount of moisture in the soil is by drainage. Farmers have various methods of draining land, that is, of carrying off the superfluous water that falls or seeps into the ground. From what you have just read (Sec. 17) about the effect of too much water in the soil, you will understand some of the benefits of drainage. If the water is carried off, there is more room for air in the soil. The roots will grow deeper. The soil will be warmer. Excess soluble substances in the soil, which may be injurious to crop growth, will be removed and the soil will really provide more available moisture during the season.

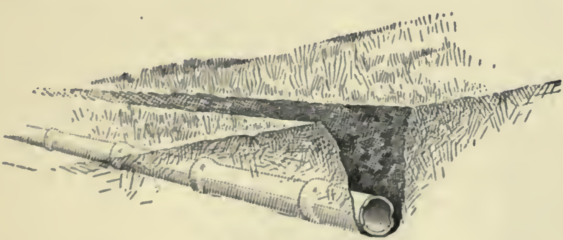
The fact that in drained land the roots can go deeper is beneficial in several ways. These roots will feed in the deeper soil and will take less water from the surface. So long as the water is not drawn from the surface layer of soil, the moisture below will not rise by the force of

capillarity (Sec. 14). It will be stored up until needed. Later in the season when a dry time comes, this store of water will rise toward the surface as the moisture there evaporates. Thus you see that drainage improves the condition of the soil in such a way as to increase its capacity to hold available water without the evils that attend the presence of superfluous water.

Deep-growing roots also open up places for the air to penetrate farther into the soil. As underground water is drained off, clay in the soil shrinks and cracks, and these cracks offer another means by which air gets into the soil. It is important to provide drainage for a clayey soil; for a sandy soil this generally is not necessary.

When land is drained, the water from rains can sink into the ground. Otherwise the rains may wash away the surface soil and injure plants.

**20. Methods of Drainage.**—The best method of underdrainage is by trenches, with hollow tiles at the



A Tile Drain.

bottom. The trench is dug two and one half feet to four feet deep. The tiles are one foot long or more and two to eight inches in diameter. They are placed end

to end, without cementing, on a gradual grade, and the trench is filled with earth. The water from the soil gets into the tiles through the small spaces where the ends join and flows through the pipe of hollow tiling. The rows of tiles are placed through the field at distances apart varying from thirty to one hundred feet. Sometimes stones are used instead of tiles. They are laid in the ditch so as to form a channel for the water.

Farmers sometimes drain their land by open ditches, but it is hard to work a field cut up in this way. When such ditches must be had, it is best, if possible, to make them so broad and gently sloping as to permit their being kept in grass and readily mowed with a machine. Sometimes the ditches are filled with stones or brush, and it is then more difficult to keep the weeds down. Such an arrangement is much less satisfactory than tile drains, which are less expensive to keep up, are more permanent, more effective, leave no obstructions on the surface, and waste no land.

## SUMMARY

Water exists in the soil as free water and film water.—Water moves through the porous soil by the force of capillarity.—Different crops use 300 to 500 pounds of water to produce one pound of dry matter.—The water serves the plant as food, to carry food, and to render the plant stiff and rigid.—Too little water robs the plant of its food and allows it to wither.—Too much water in the soil injures the plant by keeping air out of the soil, by preventing the roots from penetrating the soil, and by making the soil cold.

The moisture-holding capacity of the soil may be increased by tilling, by adding humus, and by drainage.—Underdrainage

allows the plant to root deeply, opens up the soil for the admission of air, deepens the feeding ground of the plant, increases the capacity of the soil to hold water, and lessens washing by rains. Draining by tiles is the best method of underdrainage.

## QUESTIONS AND PROBLEMS

1. What kind of soil allows the free water to pass through most readily?

2. Give illustrations of capillarity, or capillary attraction.

3. Which would be better, to water a lawn or garden a little and do it often, or give it a thorough soaking once in a while? Why?

4. Would you pick lettuce early in the morning or in the middle of the forenoon? Why? (Sec. 16.)

5. Can every piece of land be drained? What conditions are necessary in order that it may be drained?

6. It is said that wheat uses 453 pounds of water to produce one pound of dry matter. At 30 bushels to the acre (60 pounds per bushel), how many tons of water per acre would be required?

7. One inch of water over an acre weighs nearly 100 tons. Can you find what is the weight of the annual rainfall in your vicinity? How many inches would be necessary for the number of tons found in Question 6? The wheat straw will weigh one and one half times as much as the grain. How much water will it require?

8. Why will a crop on well-drained land have more time to mature than on undrained land?

9. If a cube an inch on each side is divided into cubes one eighth of an inch on each side, how many cubes will there be?

10. How many times as much surface will the little cubes have?

# CHAPTER IV

## TILLING THE SOIL

**21. Tillage.**—Tilling the soil is one of the means by which farmers improve their land. Plowing partly inverts the soil and grinds the particles together. Cultivation stirs and loosens the surface soil and thereby makes it finer. These operations change the texture of the soil, as we say.

When an entire field is tilled, the operation is called *general tillage.* This is done usually to prepare the soil for the planting of seeds or to mix with the soil manure that has been spread over the surface.

Sometimes after the plants have come up the soil is tilled between the rows of plants. This is called *inter-tillage.*

In its larger sense the word cultivation means the same as tillage. More narrowly, it means the use of the cultivator to stir the surface soil.

**22. Objects of Tillage.**—Briefly, the object of tillage is to put the soil in such a physical condition that it makes an ideal home for plant roots. There are many reasons why plants need a loose, fine soil. If the soil is in lumps, the tiny roots cannot enter it easily, and it will neither support the plant nor give it food. Tillage

Plowing with a Four-horse Team on a Ranch in Oklahoma.

Steam Plow and Seeder at Work on a Ranch in California.

gives depth of soil so that there is ample living room, a large feeding area, an abundant storage for moisture, and available plant food. A lumpy soil and a hard crust covering the surface will keep out the air, which is necessary to soil activities. We learned in the last chapter (Sec. 18) that a fine soil gives more room for water among the particles of earth. In a fine soil this moisture can circulate better and tillage is a great help to certain very important soil organisms that make plant food available, which we have not spoken about yet.

23. **Preparation of the Seed Bed.**—Seeds especially require a good soil for their growth, and tillage helps to prepare the proper seed bed. In the spring the soil is turned over so that the sun may warm it and is harrowed down into a fine smooth bed. The soil must be fine and loose, so that when the seed sprouts its delicate stems and rootlets may easily get through the soil and close to the soil particles. In some cases it is desirable to till the ground just before the young shoots come up, so as to break the crust for them.

24. **Regulation of Moisture.**—Tillage helps to regulate the amount and movement of moisture in the soil. When a few inches of the surface soil have been loosened, the rain water will sink in instead of washing off the land and being wasted.

This loose soil on top makes what is called a surface mulch. In loose earth the particles of soil are more separated, so that there is more space between them. Water does not readily pass through dry, loose soil by capillarity, for, in the loose soil, the capillary pores are broken up. So this surface mulch prevents the ground

from drying out by making it impossible for the deeper-lying moisture to reach the surface.

When possible, the land should be tilled after each rain to keep the soil loose. By repeating this so that two or three inches of soil on top are always loose and dry, the farmer can keep most crops alive even in the driest weather. Tillage, then, accomplishes two important things: it carries rain water to the roots, and it prevents moisture stored deep in the soil from coming to the surface and evaporating.

**25. Other Uses.**—Soil is often tilled to cover barnyard manure and green manures, that is, green crops intended to be mixed with the soil to form humus. These are all plowed under so that they may decay and enrich the soil. They provide valuable food for the plant and in many ways improve the physical condition of the soil.

Still another use of tillage, and one that farmers count of much importance, is the destruction of weeds. The plow, or cultivator, uprooting them, hinders their growth. The best time to kill weeds is just as they come up, and before they are large enough to do any damage.

**26. A Risk in Tilling.**—In tilling between the rows of growing crops, great care must be used not to disturb the roots. Corn and some other plants send their roots out between the rows and near the surface of the ground. While tillage is very beneficial to the corn crop, which needs plenty of moisture, the farmer must watch that the cultivator does not go deep enough to break the fine roots.

**27. Importance of Good Tillage.**—It is evident that one of the most important things for the farmer to consider is the tillage of his soil. Even though there may be plenty of plant food in the soil and plenty of water and sunshine, all these will not produce a good crop unless the texture of the soil is right. This is obtained chiefly by good tillage. Moreover, a lack of the proper amount of plant food, water, and air may be largely remedied by tillage.

1. Raise plants in two boxes of soil; let the soil in one box be undisturbed and keep the other thoroughly tilled. See whether one plant thrives better than the other.

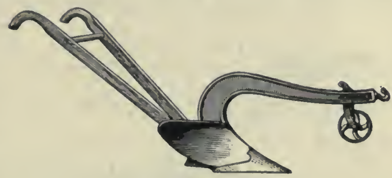
2. Raise a plant in a porous flowerpot and another in a tin can. Otherwise treat them just alike and note whether one thrives better than the other.

In 1731 Jethro Tull, in England, discovered the value of tilling the soil. He learned that he could get better crops by thorough tillage. Knowing that the plants got more food in this way, he thought that plants took in fine particles of soil as food. He wrote a book to show the value of tilling the soil for this purpose, and though his reasons were wrong he did much good by showing farmers everywhere the value of tillage.

**28. Tillage Implements—The Plow.**—The most important tools used in tillage are the plow, harrow, planker, roller, rake, and hoe.

The plow is the most important tool. Its work lays the foundation for the use of the other tillage tools. It consists of a standard to which the other parts are attached, the beam, by which it is drawn; the share, which cuts the furrow slice at the bottom; the mold board,

which turns and pulverizes the furrow slice; the landside, and the handles, by which the plow is held. Besides these chief parts are the clevis, by which the plow is attached to the doubletree, and the coulter, which is sometimes used to cut the furrow slice. A jointer is frequently attached to the beam to cut and turn the sod when plowing sod land.



A Plow.

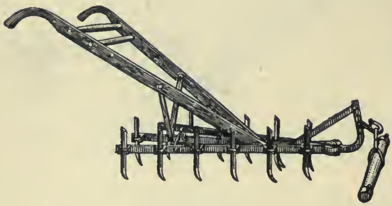
The plow cuts the furrow in slices and turns it over. At the same time it breaks up the soil, or pulverizes it. This is accomplished by grinding the different layers of soil upon each other. You can see how this is done by bending up the corners of a pamphlet and letting the leaves slip on each other. In a similar way the plow causes the soil to slip and become fine.

In order that plowing may pulverize the soil successfully, the soil must be in just the right condition of dampness. If it is too wet, the particles will stick together. If too dry, it will crumble where the plow cuts it and the rest of the furrow slice will not be broken up.

The furrow slice should not be turned over entirely, but left on its edge. In this way the weather can act on it (Sec. 23). This is especially important in fall plowing. Fields are plowed in the fall chiefly in order to let the weather act on the soil during the fall and winter.

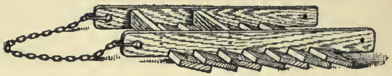
**29. Harrows, Plankers, and Rollers.**—After the field is plowed, the clods of earth must be broken up and a

fine, loose surface made. Harrows, either disk, spike, or tooth, are used for this purpose. The disk harrow is used on hard land and on sod to cut up the sod and loosen the soil from the grass roots. A fine-toothed harrow, or sometimes a planker or roller, is used for the final work of preparing the ground for the seed.



A HARROW.

The planker is made by bolting together three or four planks like clapboards in such a way as to leave a rough surface. This further breaks the clods and smooths the ground. The planker, however, is likely to destroy the surface mulch. If this is done, the ground must soon be harrowed again to prevent the formation of a hard crust and the drying of the land.



A PLANKER.

A roller is sometimes used to break the clods and to pack, or compact, the soil about the seeds. The soil soon dries out after a roller has been used, so that it should be followed by a light harrow to produce a surface mulch.

Go to a place where plows and other farm machinery are sold and examine all kinds of tillage implements.

It is time and labor well spent to take proper care of farming tools. The soil should be cleaned off from

plowshares and cultivator teeth and the machines put under cover when not in use. This is especially true of hoes, rakes, shovels, and spades which should never be allowed to get rusty.

**30. Dry Farming.**—A new or improved method of agriculture, called dry farming, has recently been used in some parts of the West, notably in western Kansas, Nebraska, eastern Colorado, New Mexico, Arizona, and Texas. The method aims to save what little rainfall there is. This is done by continually stirring the ground, so that the rains will be quickly absorbed and evaporation prevented. After one crop is removed, the land is immediately worked again. Sometimes it is tilled all of one year to store up moisture so that a crop can be grown the following year. This gives one crop in two years. With more rainfall two crops are grown in three years, and with still more, a crop is grown every year, but in each case the same principles are applied.

By these methods good crops are being raised every year where formerly a good crop was an exception. It was previously thought that an annual rainfall of about thirty inches was necessary, but farmers are producing good crops by dry farming with only ten, twelve, or fifteen inches of rain annually. Vast areas of dry lands in our country that have been considered useless, except for grazing, may now be made profitable by these new methods.

Seeds from foreign countries, especially adapted to dry climate, are selected for these regions. Among them are macaroni wheat, Turkestan alfalfa, dwarf Milo maize, Swedish oats, corn, barley, and potatoes. Up to

the present, the main product of dry farms has been wheat.

## SUMMARY

Tilling the soil is working it to change its texture.—General tillage is for the purpose of producing a good seed bed.—Intertillage is for the purpose of supplying air in the soil, conserving moisture, and destroying weeds.—Tilling makes the soil finer; increases the surface of the soil particles, thus making a larger feeding ground for the plants; increases the water-holding capacity of the soil by making a surface mulch which prevents evaporation; kills or hinders the growth of weeds.

The tools used for tillage are the plow, disk harrow, toothed harrow, cultivator, planker and roller, rake, hoe, and other hand tools.—Harrows are used to pulverize the soil.—Plankers and rollers are used to crush clods, and to make the soil more compact and bring it in contact with the seeds.—For successful plowing the soil should be just moist enough to turn in a furrow.—The main objects of plowing are to overturn and break the soil and to plow under manures.—Fall plowing is to expose the soil to the action of the weather.

The methods of dry farming aim to preserve moisture in very dry soils so that good crops can be grown there.

## QUESTIONS AND PROBLEMS

1. Why do we cultivate and hoe corn?
2. Why does the soil in a flowerpot often produce so much better plants than the same amount of soil in the field?
3. Why are weeds bad for crops?
4. Why does the garden raise larger crops than the field?
5. Why should plows, harrows, and tools be housed?
6. If soil is cultivated five inches deep, how many cubic feet to the acre are cultivated? If seven inches deep, how many cubic feet? If nine inches deep, how many cubic feet?

7. How many acres are there in a piece of land 32 rods long by 20 rods wide?

8. If land of that measurement is plowed back and forth with furrows nine inches wide, how far will a man travel to plow it?

9. If by extra cultivation a man can raise 100 bushels of potatoes more an acre, how many days' work would thus be paid for, allowing $3 per day for man and team, if the potatoes bring 25 cents per bushel?

10. How may any one who has a garden apply the lesson of dry farming?

11. Give two reasons for maintaining a surface mulch.

12. In what way may tillage injure a crop?

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# CHAPTER V

## ENRICHING THE SOIL

**31. Elements and Compounds.**—There are three foods which are necessary to the growth of plants which farmers often have to supply to the soil. These are nitrogen, phosphorus, and potassium. These substances are called *elements*. An element, according to chemistry, is a substance composed of only one kind of matter. There are about eighty distinct and different elements in the world. Most substances that we see around us are made up of several elements combined. Two or more elements combined make what is called a *compound*. A compound can be separated into two or more different kinds of matter that may have no resemblance whatever to the original compound. The elements on which the plant feeds enter the plant not as elements, but united with something else in the form of compounds. There are, in fact, about thirteen different elements that are used by plants as food. The soil generally contains an abundant supply of all but the three mentioned above. In addition to these three, lime, magnesium, and iron are indispensable to plant growth.

*Nitrogen.*—Nitrogen, being an element, cannot be separated into parts that are anything but the nitrogen itself.

It is a gas. It forms four fifths of the air we breathe; the other one fifth is mostly oxygen, as you have probably learned from your physiology text-book. Nitrogen will not burn. When available for the plant, it is combined with oxygen and a metal, as sodium or potassium. Such a substance is called a *nitrate*, as nitrate of sodium or nitrate of potassium. The root hairs, however, take from the solution of sodium nitrate the nitric acid and leave the sodium.

*Phosphorus.*—You have all heard of phosphorus, for it is commonly used in the making of matches. It is a scarcer element than nitrogen, though more familiar to us. Its chief characteristic is that it takes fire readily. Phosphorus may be obtained from bones, in which it is combined with oxygen and a metal called calcium, an important element in lime. The combination of phosphorus, oxygen, and calcium makes a substance called calcium phosphate, or phosphate of lime. Shells of lobsters, crawfish, and like animals contain calcium phosphate in large quantities. Phosphorus is found also in a mineral called apatite, and in guano. There are large deposits of phosphate rock in Florida, South Carolina, and Tennessee.

*Potassium.*—Potassium is a silvery white metal, soft as wax and light enough to float on water. It has to be kept in air-tight bottles or under kerosene to prevent its absorbing oxygen out of the air or water. Potassium is found combined with oxygen and nitrogen in a salt called nitrate of potassium, or saltpeter. In the soil it exists as sulphates and chlorides and in other forms in which it can be dissolved and used by plants. Feldspar

is one of the chief sources of potassium. It is found also in wood ashes in the form of potassium carbonate or potash. The potash[1] needed for plants can be obtained from manures and from wood ashes by pouring water through a barrel of such ashes or by plowing under the manure or ashes. The water will take the potash out of the ashes. The chief source of potash used in commercial fertilizers is found in mines in Germany, where it is mined like salt.

With a tenpenny nail punch some holes through the bottom of a tin can. Put a piece of cloth in the bottom of the can and then fill the can with ashes. Pour a pint of hot water through the ashes, catching that which drips through in some sort of vessel. Pour the same water through two or three times. Evaporate the lye so obtained, either in the sun or on a stove. That which remains is crude potash, a compound of potassium, carbon, and oxygen.

**32. The Source of the Three Kinds of Plant Foods.**— Potassium gets into the soil chiefly from the feldspar in granite rocks. The action of the weather breaks up the feldspar, and the potash is set free or made available. Growing plants take up this potash. When the plants decay or are burned, the remains or ashes contain the potash.

The decay of rocks is the original source also of phosphorus. This changes in the process of decay, and phosphoric acid results. Plants feed on this, and animals feeding on the plants take in the phosphoric acid, which

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[1] The potash referred to in tables and statements giving the amount of potash in soils and plants is another compound, viz., potassium and oxygen.

combines with other substances to make bones. By the decay of plants or of bones the plant food is again set free in the soil. And so the same material goes round and round. As the scientist says, "It performs the cycle of nature."

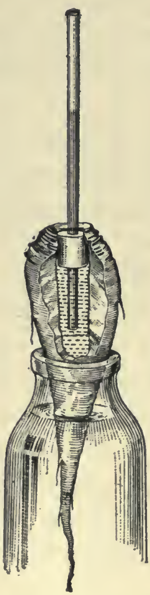
Nitrogen for the plant comes from the air (Sec. 31) and from the humus of the soil. Nitrogen in the air among the soil particles is absorbed and stored up in microscopic plant growths called bacteria. These bacteria grow in little bunches, or tubercles, upon the roots of certain plants. From these tubercles the nitrogen can be released to feed other plants, as will be explained in Chapter VI (Sec. 42).

Other bacteria not living on the roots of plants absorb nitrogen from the soil air. They help the decay of plant growths and the humus of the soil, and from this decay ammonia and nitrates are formed, making the needed plant food. These free-living bacteria are indispensable agents in the soil. As an instance of the work they do, we mention two fields at Rothamsted, England, which had run wild for twenty-five years. In one field the amount of nitrogen taken from the soil and air and left in the soil was forty-five pounds per acre per year; in the other field it was ninety-eight pounds. The greater amount of nitrogen in the second field was probably due to an abundant supply of carbonate of lime or limestone.

**33. How These Foods Get Into the Plant.**—The plant foods get into the plant and pass through it by a process called *osmosis*. The foods are dissolved in soil water, which we then call the *soil solution*, and in the solution

pass from the soil into the tiny root hairs of the plant. As fast as the plant makes use of this food, more of it is absorbed from the soil solution by the roots.

In the minute cells of which these root hairs are made, there is something called *protoplasm*, which is the living part of the plant. This protoplasm in the root hairs, by the process called osmosis, draws in this soil solution, which passes into the cells of the root and moves up through the stem and branches, and feeds all the tissues of the plant. Thus by a constantly moving current the plant gets its nourishment.



Experiment Showing Osmosis.

You can surely understand now how important it is that the soil solution should be in just the right condition to enter the plant properly (Sec. 4). You know also that the soil must be fine so that there may be a great amount of surface to hold soil water (Sec. 18).

To illustrate osmosis, carefully remove a small piece of the shell from one end of an egg and place the egg in water. The water will pass through the unbroken membrane of the egg, causing the membrane to bulge out of the shell. Another good experiment is to take a cork (rubber preferred) with a hole in it. Into the hole fit a glass tube the size of a lead pencil and a foot or more long. Bore a hole into the end of a carrot large enough to receive the cork and two inches or more deep. Nearly fill the hole in the carrot with sugar

sirup and insert the cork so that it fits snugly. Place the carrot in a bottle of water. The sirup will pass out through the cells of the carrot and the water will pass in faster than the sirup passes out, so the water and sirup will be pushed up the tube.

**34. The Use to the Plant of Each Kind of Food.**— It is still uncertain just what each of the important plant foods, potassium, phosphorus, and nitrogen, does for the plant. Some things, however, have been determined. We know that the absence of any one of these necessary to the development of a certain crop will result in a weak, unsatisfactory growth.

If there is not sufficient potassium in the plant food, the plant will grow slowly or stop growing. The addition of certain substances containing potassium to the soil will again start the plant's activities. Potassium seems especially necessary in producing vigorous fruit plants and potatoes.

One thousand pounds of winter wheat contain an average of about five pounds of potash, which is a compound of potassium and oxygen. The same quantity of straw contains about six pounds of potash. This is a heavy drain on the supply in the soil and all the potash in the waste straw should be put back into the soil. Farmers formerly got rid of the straw that was left after the wheat was threshed by burning it. After some years of this practice, the growing crops would not hold up their stalks long enough to allow the grain to ripen. The farmers then said that the land was becoming so rich that it grew wheat too large to stand up. They have since learned better. The soil needed more potash to make the stalks stronger. This potash can be put

into the soil by plowing into it the straw left after threshing. This straw decays, and finally the potash gets into the soil solution in a form that the plants can feed on.

Phosphorus makes the plant vigorous and hardy. A good supply is needed especially in the early stages of the plant's life. It helps to make the seeds plump and good. Grains contain even more phosphoric acid than potash. Some of the phosphorus in the grain is discarded when fine flour is made, and for this reason fine flour is not so complete a food for man as whole flour.

An abundant supply of nitrogen results in the production of large, healthy leaves and stalks. Hence nitrogen is especially valuable for the plants that are raised for their leaves and stalks, as lettuce, asparagus, and hay, and for those that must make a vigorous growth before setting fruit or seed. Wheat and other grains take much nitrogen from the soil. One thousand pounds of grain contain sixteen to twenty-four pounds of nitrogen. Beans, peas, and such plants contain much nitrogen; but they may sometimes leave more nitrogen in the soil than they find there, as we shall learn in the next chapter.

35. **Barnyard Manure.**—An important question for the farmer is how he shall provide the food needed by his growing crops. Close at hand he has a most valuable source of plant food. His barnyard manure contains material which the plant can easily use. Each thousand pounds of manure contain on an average five pounds each of nitrogen and potash, and three and one third pounds of phosphoric acid.

The manure may be spread over the ground or it

may be plowed into the soil. As it decays, it makes the humus which is so necessary to a rich soil. The texture

CARE OF BARNYARD MANURE—Wrong way.

of the soil and its capacity to hold moisture are improved by this means (Sec. 18).

It is asserted by some authorities that the manure "produced annually by each horse or mule is worth $27,

CARE OF BARNYARD MANURE—Right way.

by each head of cattle $19, by each hog $12, and by each sheep $2." Much of the value, however, is wasted by the slipshod way in which many farmers take care of

the manure. By exposure to rain more than half its value may be lost. To preserve its full value, manure should be kept moist, compact, and under cover, or else it should immediately be spread on the land.

**36. Other Ways of Enriching the Soil.**—Growing crops and stubble when plowed under add some of the needed food elements to the soil and improve the texture of the soil. We have read how the straw from grains returns potash to the soil when plowed in (Sec. 34). Stubble must always be plowed under. The question of plowing under green, unharvested crops, however, is one that needs the farmer's best judgment. There is some danger that the addition of such material may make the soil too dry and perhaps leave it too loose for seeding. This is especially true with light soils, and a great mass of green material should not be plowed under; with heavy soils the danger is much less. In case of a drought, such plowed-under crops will not decay properly so as to make good humus. The time to plow under green crops or "green manures" is very important and is determined largely by seasonal conditions and the crop that is to follow.

**37. Commercial Fertilizers.**—Another resource of the farmer for enriching the soil is commercial fertilizers. He can buy, by the bag, material containing nitrogen, phosphorus, and potassium in suitable form for use in the soil. In many states it is required by law that these commercial fertilizers shall be analyzed under state supervision and their sale licensed by the proper authorities. The bags in which they are packed must bear a printed statement of the composition of the fertilizer.

Thus, if the farmer knows the particular elements needed by the crop he is growing, he can choose the kind of fertilizer that contains those elements.

In some localities it is possible to buy wood ashes. These contain potash and phosphoric acid, and are first-class fertilizer when these foods are needed. Ashes do not supply any nitrogen, however.

It is cheaper, of course, for the farmer to use as fertilizer the manure produced on the farm. This also does more good to the soil. But it is sometimes desirable to supplement it with commercial fertilizers. The farmer can rely on them to give the plant quickly the desired food elements.

If you have an opportunity to work in a garden or field, experiment with small patches of land, putting no manure on one patch, cow manure on another, horse manure on another, wood ashes on a fourth, and some commercial fertilizer on a fifth. Study carefully the effect on the crops grown on the different patches.

**38. Amendments.**—It remains to mention another class of dressings which are supplied to the land chiefly because they improve the texture of the soil or improve the chemical condition. Such are called *amendments*. The chief of these is lime. Lime is added to clay soil to make it less sticky, and to sandy soil to make it more compact. Lime also counteracts in soils the effect of acids, which otherwise might harm the crop, and promotes chemical activities which result in making plant food available. It is most likely to be needed by clover and alfalfa. If these crops grow well on the soil, lime is not likely to benefit other crops.

Common salt is another substance often used on soils. It helps to set free the phosphates in the soil so that the plant can use them. The best results are secured in dry seasons, because the addition of a little salt aids in the movement of the soil water so that more becomes available to plants. Salt should be used sparingly, and not at all on a potato or a tobacco crop. It will pay better to spend the money for commercial fertilizers.

Gypsum or "land plaster" is also a common amendment. Others are marl, muck, and chalk.

In winter, experiments may be performed by planting seeds in several boxes or flowerpots, filling them with sand, mixtures of sand and garden soil, sand and manure in various proportions, sand and leaf mold, and sand with various commercial fertilizers added. Keep a record of the kind of soil in each box or flowerpot. Watch the growth of the plants and decide which are the better soils.

**39. Nitrification.**—We have said that the various compounds which contain the elements of plant food must be changed before the plant can absorb this food. Such changes are constantly going on in the soil. The process by which the different compounds containing nitrogen are changed is called *nitrification.* Lime added to the soil often helps this process.

Nitrification is the work of minute organisms which are active under certain conditions. It consists in the union of nitrogen compounds with oxygen, and is the final step in the preparation of soil nitrogen for the use of plants. To have the conditions right for this preparation of nitrogen for the plant, there must be in the soil

air, moisture, sufficient warmth, and the absence of strong sunlight. There must be food for the minute organisms; and the soil must contain some compound, such as calcium carbonate (limestone), with which the nitrogen may unite.

## SUMMARY

Everything in the world is made up from about eighty different elements, thirteen of which go to make up plants and animals. The farmer is concerned only with these thirteen elements, and he has frequently to provide for three—nitrogen, phosphorus, and potassium.—Nitrogen is a gas and constitutes four fifths of the air.—Phosphorus is the substance used on the ends of matches. It is extracted from bones and other substances.—Potassium is found in certain rocks. It is one of the elements in potash, and is obtained from wood ashes.

The three chief plant foods are compounds of nitrogen, phosphorus, and potassium.—The chief nitrogen compounds are nitric acid, ammonia, sulphate of ammonia, nitrate of potassium, and nitrate of sodium.—The chief compound of phosphorus is calcium phosphate.—The chief potassium compounds are nitrate of potassium, sodium nitrate, potassium chlorid, and sulphate and muriate of potash.

All these compounds, except ammonia and nitric acid, are called salts and may be found in solution in the soil water. They are derived from the decay of rocks and bones, from wood ashes, and from manures or fertilizers.—These salts reach the plant through its roots. A good supply of the compounds of nitrogen, phosphorus, and potassium is necessary to the healthy growth of plants.

The most important enrichment for the soil is barnyard manure. It contains all three of the plant foods and also benefits the land by improving its texture.—Green crops and plowed-under stubble enrich the land and improve its texture.—Commercial fertilizers contain plant food in a soluble form and so

produce quick results.—Nitrification is the change that takes place in the soil, by which locked-up nitrogen is made available for the use of the plant.

## QUESTIONS AND PROBLEMS

1. What is an element?

2. What is a compound?

3. How many elements make up the earth?

4. How many elements does the plant use?

5. Which elements must the farmer often supply?

6. By what process does the plant get its food from the soil?

7. Name four kinds of plants that are raised for their leaves or stalks. What element is especially valuable for such plants?

8. Is it a good practice to rake leaves into the road and burn them?

9. Why are soils derived from granite rocks more durable than those from limestone?

10. One thousand pounds of tobacco take from the soil 42 pounds of nitrogen, 5 pounds of phosphoric acid, and 57 pounds of potash. If the nitrogen is worth 15 cents a pound, and each of the others 5 cents a pound, what is the total value of the substances taken from the soil?

11. One thousand pounds of corn take from the soil 18 pounds of nitrogen, 17 pounds of phosphoric acid, and 4 pounds of potash. What does the corn cost the soil in plant food or money cost, based on $10?

12. If 1,000 pounds of wheat remove 52 pounds of potash from the soil, how much will 40 bushels to the acre remove per acre?

13. If the straw weighs one and one half times as much as the grain and 1,000 pounds of straw remove 6.3 pounds of potash, how much will the straw of 40 bushels remove?

14. The corresponding amount of phosphoric acid is 7.9 pounds for the grain and 2.2 pounds for the straw per 1,000

pounds. How much phosphoric acid will be removed by the 40 bushels of wheat and the straw?

15. The corresponding amount of nitrogen is 20.8 pounds for 1,000 pounds of grain and 4.8 for 1,000 pounds of straw. How much nitrogen will be removed by 40 bushels of grain and its straw or Problem 13?

16. If a ton of barnyard manure contains 10 pounds of nitrogen, 6 pounds of phosphoric acid, and 9 pounds of potash, how many tons per acre should be used to make up for what the wheat removes? It may be necessary to multiply the result by 5 because only part, say, one fifth, of the plant food is available the first season. Ten to 30 tons is considered the proper amount by different authorities.

17. What is an amendment?

18. What is meant by nitrification?

## CHAPTER VI

### LEGUMINOUS PLANTS.—ROTATION OF CROPS

**40. Clover and Its Relatives.**—One of the most useful crops that can be grown on the farm is clover. This may seem surprising to you because clover supplies no food for man. Its usefulness consists in its improvement of the soil for the growth of other crops in addition to its feeding value for farm stock. A great many years ago it was known that a crop of clover improved the soil in which it was grown, but only recently was the reason for this discovered.

The clover belongs to a family of plants called leguminous plants, or legumes. These plants have very irregular flowers generally shaped somewhat like butterflies, and seeds in a long pod or legume. The leaves are compound, that is, they are made up of three or more leaflets like the clover and locust. The family is called also the pulse family. To this family belong, besides the clover, the locust tree, peas, peanuts, beans, vetch, alfalfa, and some other plants.

Make a collection of the flowers of the clover, pea, bean, alfalfa, and locust and note the similarity. Notice that the leaves of all such plants are compound.

**41. Fixation of Nitrogen.**—One reason that clover is so useful to the soil is because it takes nitrogen from the soil air and makes it available for the nourishment of other plants. The process of getting nitrogen from the air and leaving it in the soil is called fixation of nitrogen. Many books have been written on the subject, and many experiments have been made with the object of finding other ways of fixing nitrogen from the air. It can be done by the aid of electricity.

**42. Legumes as Nitrogen Gatherers.**—Clover and other legumes have a very special way of making nitrogen available as plant food. One might expect that, since nitrogen is in the air, all plants could get it through their leaves; but most, if not all, plants are unable to do this.

RED CLOVER ROOTS SHOWING TUBERCLES.

The leguminous plants have on their roots little bunches or tubercles. These tubercles contain minute, simple plants called bacteria. These bacteria can take nitrogen gas from the air and compound it with other things, making nitrates, which furnish food for the plants

on which the bacteria live. When the roots decay, the nitrogen is left in the soil, and other plants can then use it (Sec. 32). Moreover, the bacteria may make more nitrates than can be used by the plants on which they grow. The extra supply goes into the soil.

Sometimes the germs from which the clover bacteria grow are not found in the soil, and the clover or other leguminous plant does not grow well. In such case the germs can be supplied by adding, at the time of planting the seeds, soil which contains the germs, obtained from land where clover has been grown successfully. This process of adding bacteria is called *inoculation.*

Carefully dig up a bunch of clover and wash away the soil from the roots so that you can see the tubercles. It will not do to pull up the plants, as the tubercles will then be left in the ground.

These bacteria, of which there are many kinds, are similar to the bacteria that you may have learned about in your physiology lessons. Fermentation and decays of various kinds are due to bacteria.

**43. Other Uses of Legumes.**—Leguminous plants benefit the soil in another way. They are deep feeders, that is, their roots go far down into the soil. Thus they may feed on material that could not be reached by other plants. When their deep-reaching roots decay, they leave the ground porous for the entrance of water, air, and the roots of other plants.

Clover crops are frequently plowed under, and in this way the plant food which they contain is made available for other plants and humus is added to the soil.

Leguminous plants have large leaves and stems that are useful for forage. Alfalfa is becoming especially popular because it produces a great quantity of hay; several crops may be taken off in one season (Sec. 102). The seeds produced by certain leguminous plants are especially nutritious as food for man and beast. Beans, peas, and peanuts, for example, have been used for food in all ages.

**44. Rotation of Crops.**—It is evident from the above how advantageous it is to alternate leguminous plants with other crops. There are other reasons, however, why the wise farmer does not raise the same kind of crop year after year on a piece of land. He plans a series of three or four different crops which he grows in succession on each field. This alternation of a series of crops on the same piece of land is called rotation of crops.

**45. Rotation is a Weapon Against Pests.**—An important reason why rotation of crops is not only expedient but necessary is this—many plants are attacked by their own particular kind of insects or fungous diseases. After a crop has been grown on a piece of land for some time, the soil is filled with the eggs or larvæ of the insect pest or with the germs of the fungus. Therefore it becomes necessary for the farmer to starve out these pests by changing the crop to one on which they do not feed. For example, it becomes almost impossible to raise summer squash in certain gardens because of the brown squash bug. If squash is not planted there for a few years the bugs go elsewhere and a few crops of squash can be grown before the bugs return. Potato scab lives in the soil, and if once estab-

lished and not eliminated by rotation it continues to infest successive crops of potatoes.

**46. Rotation Destroys Weeds.**—If crops of grain which have no summer tillage are raised continuously, the ground becomes overrun with weeds. If a crop of grain is followed by corn or potatoes or other tilled crop, the soil is stirred and the weeds are thus destroyed. Different crops require different treatment, and this varying treatment is good for the soil. Potatoes and other plants that have food products on their roots have to be dug out of the ground, and this digging leaves the soil in good condition for the next crop.

Much may be learned by observing the practices of neighboring farmers and by noticing that flowering plants grow much better after being transplanted. Note, also, the difference in vigor of crops on new land and on old land.

**47. Rotation Practically Enlarges the Farm.**—Different plants have different feeding habits. Some plants feed near the surface of the ground and exhaust the food there, while others send their roots down and feed in an entirely different part of the soil. This practically enlarges the farm on which crops of different feeding habits are rotated. The roots of clover often go down several feet in sandy soil. Wheat possesses an extensive root system, while barley is shallow rooted. By deep feeding not only is the surface soil relieved but plant food is also brought up and left near the top for surface feeders to use later. Furthermore, some crops mature early while others feed during the entire season. Early peas, for example, are grown in July, while corn con-

tinues to grow till October. The farmer can take advantage of these conditions in the rotation of his crops. Winter wheat planted in October will grow through the late fall and early in spring. After it is cut in midsummer there is, in southern latitudes, still time for a short-time crop, and thus the land is used throughout the season. Oats and barley mature about three months after sowing.

**48. Rotation Regulates the Food Supply in the Soil.**— When one crop is raised in the same soil for a number of years the land tends to wear out. This one crop depletes the soil of certain kinds of plant food so that after a while the crop will not grow well. But the same soil can still supply sufficient food for a different crop. This is not because different plants use different food materials, for it has been found that all plants use practically the same kinds of foods. It is because different plants use different proportions of the same foods. For example, 1,000 pounds of tobacco remove from the soil 45 pounds of nitrogen, while the same amount of Indian corn removes only about 25 pounds. The tobacco removes 50 pounds of potash, while the corn requires only 10 pounds. On the other hand, 1,000 pounds of clover may actually add to the soil one half as much nitrogen as it removed and take out only 22 pounds of potash. From this it will be seen that clover is a good crop for land deficient in nitrogen, and Indian corn for land from which the supply of potash has been largely drawn.

The following table shows the number of pounds (to the nearest whole number) of each of the principal

plant foods taken out by 1,000 pounds of the given crop.[1] (See also Table I in the Appendix.)

| | Nitrogen | Phosphoric Acid | Potash |
|---|---|---|---|
| Wheat (grain and straw)....... | 34 | 11 | 14 |
| Oats (grain and straw)........ | 32 | 11 | 26 |
| Indian corn.................. | 25 | 9 | 10 |
| Clover [2]..................... | 20 | 4½ | 22 |
| Tobacco...................... | 45 | 5 | 50 |

**49. The Norfolk System of Rotation.**—It has taken many years of observation and study to determine what crops should be used in a series for rotation. The first system to gain attention in America, and one still much used, consists of roots (turnips), barley, clover, wheat. This is called the Norfolk System because it originated in Norfolk County in England. It is of more importance for having called attention to crop rotation than it is for the actual alternation of crops involved. Turnips, which are deep feeders, are followed by barley, which feeds near the surface. Both of these crops remove nitrogen, so clover (a deep feeder) is next grown in order to renew the supply of nitrogen. The system is, of course, varied to suit local conditions. In the United States corn and potatoes take the place of turnips. When stock is kept on the farm the Norfolk System may be changed to allow crops of mixed grass and clover for

[1] It should be understood that these numbers are only approximate for the reason that the proportion of straw or stalks to the grain or seeds varies. They illustrate the point, however.

[2] As before stated, although the clover contains a large amount of nitrogen, it gets much of it from the air.

two or three years. Or, if not much stock is kept, sugar beets, barley, clover, and wheat may be the series. Oats may be grown instead of barley, and rye in place of wheat. In certain states corn is used in the series for one or two years. In Ohio, clover, potatoes, and winter wheat are sometimes grown. In Massachusetts, potatoes and corn are grown for two years and grass and clover for three years. A common rotation on dairy farms is corn, oats, wheat, clover, and timothy for two years. The rotations that are employed in various regions and under various circumstances are almost without number.

## SUMMARY

Clover is one of the most useful crops on the farm. It belongs to the family of leguminous plants, which includes also alfalfa, peas, beans, and vetch.

Leguminous plants all have the power of fixing the nitrogen of the air and making it available for plant food.—These plants are known by a peculiar butterfly-shaped flower, seeds in a long pod, and compound leaves.—They are deep feeders and so loosen the soil.—They have many leaves, which furnish much forage. —They also produce many seeds, which are a valuable food for man and beast.

By rotation of crops is meant the changing of the crop from year to year on a given piece of land.—Rotation of crops is desirable for the following reasons:

Different crops are infested by different insects and associated with different weeds;

Different crops take different amounts of plant food;

Different crops send their roots down to different depths;

Crops vary in their feeding time, some maturing earlier in the season and some later;

Different crops need different treatment.
The supply of humus can be maintained in the soil.

## QUESTIONS

1. What is a leguminous plant?

2. What are the characteristics of its leaves, seeds, and flowers?

3. Give three reasons why legumes are useful to the farmer.

4. Would you plow under the whole clover crop or only the stubble?

5. How does the alfalfa crop differ from the timothy?

6. What is meant by rotation of crops?

7. Give five reasons why rotation should be practiced.

8. Give one series of crops for rotation not given in the text and explain its advantages.

9. What should govern the farmer in deciding what crops he will raise?

10. Would you follow a crop of oats with a crop of wheat? Why?

11. Why is it bad practice to raise tobacco on the same piece of land year after year?

12. What system of rotation do the farmers in your neighborhood use? Ask them, and ask them why.

## CHAPTER VII

### PLANT FOOD AND HOW IT IS USED

**50. The Factory of Nature.**—The plant, as it grows, is manufacturing products. It uses the food material which it gets from the soil and the air to make starch, sugar, oil, and other products. The plant works with only a few different elements, but by putting them together in different proportions it makes several products. Just as our mothers with flour, milk, water, sugar, and yeast or baking powder make many kinds of bread, cake, cookies, doughnuts, and rolls, so nature with oxygen, hydrogen, and carbon makes starch, sugar, and oil. Adding to these elements nitrogen, sulphur, and phosphorus, nature—that is, the plant—makes another class of foods called proteids.

**51. Oxygen, Hydrogen, and Carbon.**—Three elements which are necessary to every plant product are oxygen, hydrogen, and carbon.

*Oxygen.*—Oxygen is a gas that forms a part of air and water. It forms about one fifth of the weight of the air. Forty-seven per cent of the whole crust of the earth is made up of oxygen. Whenever anything burns you may know that oxygen is present, for nothing can burn without oxygen. Plants, you know, can be

burned. This is because the plant is full of carbon which unites with the oxygen in the air.

*Hydrogen.*—Hydrogen is a gas obtained from water. It is the lightest gas known and it burns with a nearly colorless, hot flame.

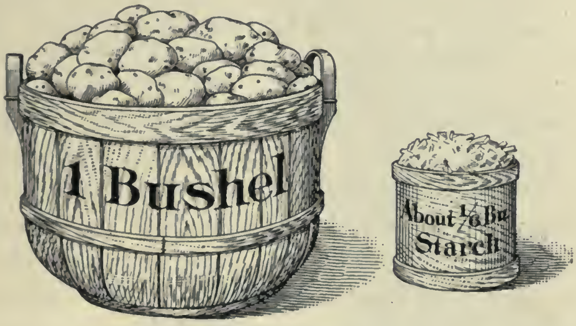
*Carbon.*—Carbon exists commonly as charcoal. The black substance on the end of a burned match is carbon. Wood and coal contain carbon, and when they are burned the carbon escapes to the air in the form of gas. The carbon combines with oxygen and forms this compound gas called carbon dioxide, or carbonic-acid gas. The breath from our lungs contains carbon dioxide, as you have learned in your study of physiology. Man and beast do not use the carbon in the air, but plants are constantly taking it in. Carbon is very necessary for their growth.

**52. The Products of Plant Growth.**—Some of the products which plants produce as they grow are starch, sugar, oil, protein, gums, and woody tissue.

*Starch.*—You are probably familiar with starch as a substance used in starching clothes. It is also a valuable food for man. Potatoes are valuable chiefly for the starch they contain. Starch is found in fruits, seeds, roots, tubers, and leaves. In making starch the plant combines oxygen, hydrogen, and carbon.

A few drops of tincture of iodine may be obtained from a drug store or from a physician. A drop put into a little boiled starch will turn it blue; this is a *test* for starch. By boiling for a few moments small pieces of potato, flour, meal, crushed seeds, pieces of beets, carrots, etc., and testing, the presence of starch may be shown. Pour boiling water over the specimen in a

cup; wait until it is cold before applying the iodine test. Any part of a plant, as leaves, bark, or twigs, may be tested for starch in the same way.




COMPARATIVE YIELD OF STARCH FROM ONE BUSHEL OF POTATOES.

*Sugar, Oil.*—Sugar and oil are made from these same three elements. Sugar is found in most fruits, and especially in sugar cane, sugar beets, and sugar maples. Oil is found in small quantities in all grains, and in large quantities in nuts and many kinds of fruits and seeds. Olives, for example, contain a good deal of oil.

*Protein.*—Protein is the name given to a group of food substances containing nitrogen. The most important substance in this group is *proteid*, which is found in grains and fruits. The sticky part of wheat is proteid. It is abundant in beans, peas, and other leguminous plants. It is valuable as food because it is used by the body in building up muscle. In making protein, the plant uses (as we have noted above) nitrogen and a little sulphur and phosphorus in addition to the three usual elements—oxygen, hydrogen, and carbon.

Place a teaspoonful of flour on a piece of coarse muslin or linen (an old handkerchief is suitable). Bring the sides and corners up together to make a sort of bag. Dip it several times into a basin of water and squeeze it. The part of the flour that comes through is starch; and the sticky mass inside the cloth is gluten, a proteid.

*Wood Tissue.*—What we call *woody tissue* forms the great bulk of the plant. It is the trunk and limbs of trees. As wood and lumber it is an important product of plant growth. The woody tissue, like starch, sugar, and oil, is made with oxygen, hydrogen, and carbon.

**53. How the Plant Digests its Food Elements.**—The plant manufactures its products by the action of the living cells which its leaves contain. In these cells is a green substance called *chlorophyll*. This substance and the sunlight on the leaves acting together change the food which the plant has absorbed. Carbon dioxide, you remember, comes in through the leaves (Sec. 4). The water absorbed by the roots contains oxygen, hydrogen, nitrogen, and some other foods. The water and the carbon dioxide meet in the leaves and other green parts of the plant. There, in a wonderful way, they are combined so as to make starch and the other plant products.

**54. Changing Starch to Sugar.**—Starch, as we have just learned, is made in the leaves. But as a product of the potato plant, for example, it appears in growths on the root, called tubers. How is it moved from one place to the other? Starch and the other plant products cannot be moved bodily from one place to another. In a plant there can be no transfer unless the

material moved is dissolved, or in solution, as we say. Now, starch will not dissolve in water, and therefore if the starch is to be moved it must be changed to something that is soluble. Much of the starch made in plants is changed to sugar, which is soluble. The sugar is then dissolved in water and carried down into the roots and tubers of plants. The sugar is used by plants in their growth and development.

POTATO PLANT, SHOWING POTATOES OR TUBERS.

**55. Changing Sugar to Starch.**— This sugar which has been carried in solution is not stored up as sugar, but is changed to starch again. The greater part of all vegetable foods consists of such stored-up starch.

This stored-up starch may again change to sugar if the plant needs it. The difference between a ripe and a green apple is chiefly a difference in the starch and sugar which they contain. The green apple makes trouble for the boy because the starch is not digestible. If, however, the green apples are cooked and made into pies or sauce, the starch is made digestible and causes no trouble. A change from starch to sugar is indicated by the sweet

taste of sprouting potatoes and roots. In ripening fruit also the stored-up starch is changing to sugar.

**56. The Composition of Certain Vegetable Products.**—The following table will give an idea of the amount of starch and sugar, oils, and protein in various vegetable products. Starch and sugar are combined under the head of carbohydrates:

TABLE SHOWING AVERAGE PERCENTAGE OF DIGESTIBLE CARBOHYDRATES, FATS OR OILS, AND PROTEIN.[1]

| | Protein | Carbohydrates | Fat or Oil |
|---|---|---|---|
| Corn | 7.14 | 66.12 | 4.97 |
| Wheat | 10.23 | 69.21 | 1.68 |
| Timothy hay | 2.89 | 43.72 | 1.43 |
| Potatoes | 1.36 | 16.43 | |
| Carrots | .81 | 7.83 | .22 |
| Alfalfa hay | 10.58 | 37.33 | 1.38 |
| Clover hay (red) | 7.38 | 38.15 | 1.81 |
| Apples | .7 | 18. | |

**57. The Production of Heat.**—It is interesting to know that a plant, like an animal, produces heat when it is growing. Although the amount is small, experiments have proved that the temperature of sprouting seeds may be 18° to 36° Fahrenheit higher than that of the surrounding air. In the act of flowering, plants may be as much as 14° Fahrenheit warmer than the surrounding air.

Into a wide-mouthed bottle place a number of seeds ready to germinate. After twelve hours cork the bottle tightly, and through the cork run a thermometer after taking the temperature of the room. Several hours later read the thermometer.

[1] *Farmers' Bulletin No.* 22, revised edition, except the figures for apples. By courtesy of the Office of Experiment Stations.

**58. The Production of Seeds.**—A study of plant life seems to show that so far as the plant is concerned, the object of its existence is to produce seed. This, then, is another important use the plant makes of its food and appears to be the most exhausting effort the plant makes. When the seed is produced, the plant stops its growth for the season, and in many cases dies. Some plants produce seed and die in one year. These we call *annuals*. Others store up nourishment for one year, use it all the second year in producing seeds, and then die. Such plants are *biennials*. Clovers and some other plants, if cut before they bear flowers, make an extra rapid growth to complete their work of producing seed. The farmer can profit by this and get several crops of clover or alfalfa in one season.

EXPERIMENT SHOWING HEAT GIVEN OFF BY GERMINATING SEEDS.

Seeds form a large part of the food of man and animals. It is, therefore, greatly to our advantage that plants seem to give all their energies to the production of seeds.

## SUMMARY

The plant combines certain elements to manufacture products.—Important elements in the growth of plants are oxygen, hydrogen, and carbon.—Oxygen and hydrogen are gases which in combination form water.—Carbon is an element that exists commonly as a black mass in charcoal.

The plant, like the animal, uses its food to build up tissue, to make chemical changes, and to produce heat.—The plant makes starch, sugar, oils, protein, and woody tissue.—Starch, sugar, oil, and protein are valuable foods for man.—Proteid is an important food substance found in grains, fruits, and legumes.

The food eleménts are manufactured into products in the leaves and other green parts of the plant.—Insoluble starch may be changed to soluble sugar and carried to some part of the plant where it is again changed to starch and stored up for future use.

Vigorous growing plants produce some heat, but not so much as animals.

The production of seeds is the most important thing the plant does.

## QUESTIONS AND PROBLEMS

1. What is the difference between starch and protein?

2. Name ten foods that are eaten chiefly for the starch they contain.

3. Why is it better to store up food as starch than as sugar?

4. Why does the plant sometimes change its starch to sugar?

5. Why are ripe apples safer to eat than green ones?

6. Would you cut clover before it blossoms? Why?

7. Water is $\frac{1}{9}$ hydrogen and $\frac{8}{9}$ oxygen by weight. How much oxygen is there in 45 pounds of water?

8. How many pounds of carbohydrates, fats or oils, and protein are there in 20 bushels of corn? In 25 bushels of oats?[1]

9. How many pounds of apples would you have to eat to get as much proteid as a pound of potatoes yields?

10. Which of the foods listed in the table on page 68 has the greatest amount of food stuff in a pound?

11. Name the products of the following plants: Sorghum, carrot, flax, hemp, oak trees, hickory.

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[1] A bushel of oats weighs 32 pounds. A bushel of corn 56 pounds.

# CHAPTER VIII

## PLANT ENEMIES: WEEDS, INSECTS, AND PLANT DISEASES

**59. What a Weed Is.**—A weed is a plant growing where it is not wanted. It is a plant so well adapted to the place where it grows that it crowds out more desirable plants. A plant that is an annoying weed to some farmers may elsewhere be cultivated in flower gardens. For example, the sweet clover is a weed in the Central States, but it has been cultivated in New England gardens for its attractive blossom.

**60. Why Weeds are Enemies.**—Weeds are enemies because they prevent the growth of plants that are wanted. If a man wants to raise lettuce and finds half of his crop purslane, although he might eat the purslane for greens, yet he will be disappointed. Weeds generally grow fast and vigorously. They take from the soil moisture needed by the crops, which dry up without it. Weeds take also the plant food and so rob the crop. The amount of available plant food in the soil at any one time is limited, and a few days of rank weed growth may use up a season's supply and retard plant growth until more is made available. Weeds frequently have large leaves, and they cover the ground and keep from the

growing crop the sunlight which it needs. They also furnish lodging and food for insects that may later attack the crop. Sometimes they poison animals in a pasture. At all times they are unsightly and a disgrace to the owner. "I went by the field of the slothful, and by the vineyard of the man void of understanding; and lo! it was all grown over with thorns, and nettles had covered the face thereof." It is important to note that certain weeds follow certain crops and certain methods of farming.

**61. Classes of Weeds.**—Weeds, like other plants, are divided into classes—*annuals*, *biennials*, and *perennials*, according to their habit of producing seeds and length of life. The chickweed is an example of the first class. It comes up from the seed in the spring, blossoms in midsummer, produces seeds, and dies the same year. Biennials may be represented by the bull thistle. This plant comes up from the seed, and the first year does not blossom but stores up nourishment. The second year it uses the nourishment to produce seed and then dies. Beets, carrots, turnips, and such plants as produce a fleshy root the first year are biennials. An example of the third class is the Canada thistle. It comes up from the seed, produces seed after one or more years, and continues to live perhaps for many years. Perennial herbs die down to the ground in the fall and grow again from the roots in the spring; shrubs and trees live on year after year.

**62. Annuals, and How to Kill Them.**—Annual weeds follow tilled crops. Among the annual weeds may be mentioned the pigweed, shepherd's purse, purslane, rag-

weed, prickly lettuce, and smartweed. In fact, most of the common garden weeds are annuals. These are the easiest to kill. If they are prevented from going to seed, and if the young plants are hoed up and covered, that is the end of them. The seeds of some weeds are deeply buried, and as the land is cultivated these are brought near the surface and soon sprout. Constant watchfulness is therefore necessary even after the first growth of weeds has been cleared away. It is often well to let the ground lie a week or two after plowing before it is seeded, so that the weeds may have an opportunity to sprout. They will then be killed by the

THE COMMON PRICKLY LETTUCE (Annual).

Small-leaved Burdock (Biennial).

cultivation incident to planting. This gives the crop a chance to start before a new lot of weeds springs up. Many annuals, and other weeds as well, may be killed by burning over a piece of ground before plowing. It is necessary only to prevent seeding to exterminate annuals.

**63. Biennials, and How to Kill Them.**—Common biennials are burdock, wild parsnip, teasel, poison hemlock, and bull thistle. It is more difficult to get rid of biennials, for even though they are mowed off, the roots are left in the ground and they may send up a stem to produce seeds the second year. On small patches, as lawns, this class of weeds may be killed by cutting off the plant just below the ground with a long-handled chisel called a spud. Any cultivation that prevents such weeds from going to seed will help to free the land from them.

**64. Perennials, and How to Kill Them.**—The great majority of weeds are perennials. Among these may be mentioned Canada thistle, plantain, dandelion, oxeye daisy, mallow, yellow dock, and toad flax or snapdragon. These are the most difficult of all weeds to destroy, because both the tops and the roots must be killed. As with the other two classes, seed production should be prevented by persistent mowing. The root or underground stem should be plowed up or dug up and exposed to the sun of summer and the frost of winter or raked off and burned. The roots may sometimes be starved by preventing any green part to live above ground. For example, dandelions in a lawn may be killed by cutting off the plant an inch or more below the

Toad Flax (Perennial).

surface of the ground and pulling out the top. This can be done very rapidly with a spud.

On small areas weeds may be smothered by covering with straw so that they will get no air or light; on large fields a sod-forming grass may be grown for the same purpose. Salt, or strong acid, is sometimes used on small areas to kill the roots of weeds.

In general, it may be said, the three methods of killing perennials are prevention of seeding, thorough and continued cultivation, and smothering by crops. Recent experiments show that wild mustard and some other weeds may be killed or checked by spraying with certain chemicals, as a ten-per-cent solution of iron sulphate. This does not injure cereals, corn, grass, or clover, but retards the growth of weeds to such an extent that the crop is increased twenty per cent.[1] There can be no effective weed control unless fence corners, roadsides, and waste places are kept clean.

Let each pupil bring into class every noxious weed he can name.

**65. Description of an Insect.**—An insect is a small animal that has six legs and its skeleton on the outside. The body is divided into ringlike parts attached to each other. These are called segments and are in three groups—the *head*, the *thorax*, and the *abdomen*. The head has attached to it the jaws, feelers, and eyes. The thorax has three rings, to which are attached the six legs and the two or four wings, if the insect has any.

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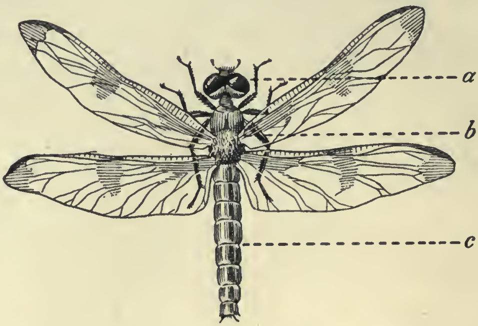
[1] *Science*, November 22, 1907, p. 694.

The abdomen is segmented and has a row of pores or breathing holes along each side.

**66. Life History of Insects.**—Insects hatch from eggs as do many other animals. But instead of growing regularly, they pass through a change, or *metamorphosis*, as it is called, the young being somewhat different from the adult. For example, the young of the butterfly and moth is a caterpillar having a wormlike body and many legs. This caterpillar, which is called a larva,

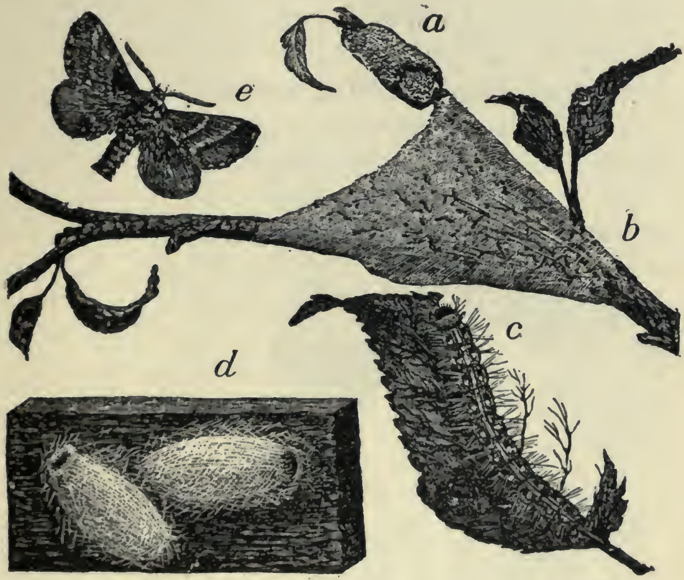



TYPICAL INSECT. *a*, head with eyes and mouth parts; *b*, thorax, with legs and wings; *c*, abdomen, showing segments.

grows rapidly and then passes into the pupa stage. In this stage it is inclosed in a rather hard shell often covered with a silk case called a cocoon. It is quiet, and eats nothing. It may occupy this stage for days, weeks, or even over winter. After a time it comes out as an adult insect. It is in the larval stage that many insects do their harm by eating vegetation.

Some insects, as the squash bug, the grasshopper, and the cricket, do not pass through a complete change,

but have, when hatched, the same form as the adult except that their wings are wanting. Such insects molt, or shed their skin, several times; and after each molt their wings are larger than before.




APPLE TREE TENT-CATERPILLAR. *a*, eggs; *b*, tent in which larvæ live; *c*, larva feeding; *d*, cocoons; *e*, adult male moth.

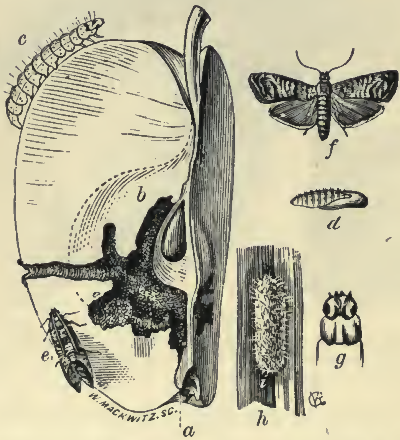
Insects lay great numbers of eggs, often several hundred. The queen bee lays several thousand in a day; and it is said that white ants lay eighty thousand a day for two years.

**67. Classification of Insects.**—In agricultural discussion, insects are sometimes divided into two groups, *cutting* and *sucking* insects. Cutting insects bite off

parts of the leaf or plant and devour them. Such insects are sometimes so numerous that they strip a bush or tree of its leaves in a few hours. Sucking insects insert their long, slender mouth parts into the plant and suck the juices from it. Some insects belong to one group in one stage of their existence, and to the other group in another stage.

**68. Some Common Cutting Insects.**—Examples of the cutting insects are the larvæ of the codling moth, the canker worm, the cabbage worm, and the potato beetle.

The codling moth is one of the most injurious of insects. The adult is a small gray moth about one half inch long. It lays its eggs on the leaves or on the apples just as the petals fall, or later, if it is the second generation. The larvæ hatch and feed their way into the apple, which may soon fall if it harbors the first generation. Afterwards the larvæ work their way out of the apple and crawl into a crevice of the bark or other similar place, from which they emerge as adult insects. If it is the last brood of the season, the pupa remains over winter. The larvæ pupate in




Codling Moth. *a*, the entrance hole; *b*, the burrow; *c*, the larva; *d*, the pupa; *e*, moth at rest; *f*, moth with wings spread; *g*, head of larva; *h*, cocoon containing pupa.

some crack or hole, or under some scale of the bark. If the tree is too smooth they drop to the ground and go into it through some crack, or remain under rubbish or clods. The larva is the white worm so familiar in apples.

The canker worm is the larva of a small ash-colored moth, the female of which is wingless. The larva is sometimes called the measuring worm because of its method of traveling by looping its body. The eggs are laid in patches on the bark of a tree. The larvæ will strip the foliage of the tree with great rapidity. After the worms have matured they swing themselves down by a silken thread, burrow in the ground, and there go into the pupa state. The last brood stays in the ground over winter.

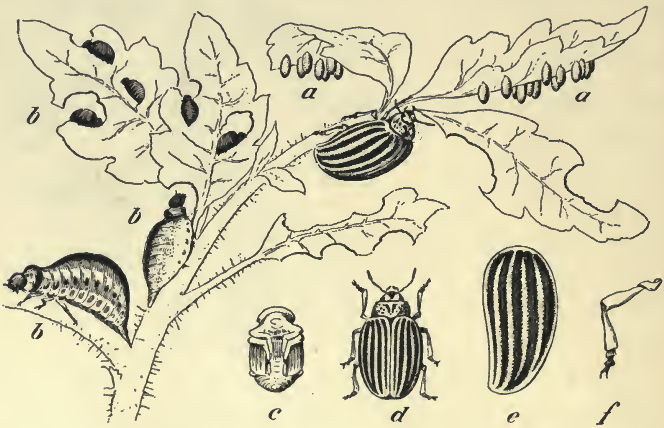
CANKER WORM. *a*, adult male; *b*, adult female moth; *c*, cluster of eggs; *d*, larva; *e*, larva swinging down from a tree to burrow into the ground.

The cabbage worm is the larva of the well-known white cabbage butterfly. It is greenish in color, tapering at each end, and covered with fine white down or hair. The eggs are laid on the leaves of the plant. In ten days they hatch, and the larvæ feed about three weeks. The pupa stage is only about two weeks.

There are generally two broods in a season, one in May and one in July.


CABBAGE WORM. *a*, larva; *b*, chrysalis; *c*, butterfly.

The potato beetle at one time caused an immense amount of damage. The adult is about one half inch




POTATO BEETLE. *a*, eggs on underside of leaf; *b*, larva that eats the leaves; *c*, pupa; *d*, perfect insect; *e*, wing cover; *f*, leg.

long with ten stripes along the back. In the Central States there are three broods, the last one remaining in

the ground over winter. The other two feed about twenty days each, and remain quiet in the ground about ten or twelve days. The larvæ will double in size in a few hours.

**69. Some Common Sucking Insects.**—Examples of sucking insects are plant lice, chinch bugs, the Hessian fly, and the grape phylloxera. Plant lice is the name given to a group of small insects that have long beaks with which they pierce the plant and suck the juices. Some are protected by a thin covering, from which they get the name of scale insects. A noted example of these is the San José scale insect, one of the most destructive to orchards. This insect is so dangerous that in some states it is illegal to sell trees infested with it.

The chinch bug is less than a quarter of an inch long, but it is said to cause more damage than any other known species of insect. It is brown in color, with white fore wings, each having a dark spot near the middle. These insects are the greatest enemies of the wheat crop. They sometimes attack corn also, "fairly blackening the stalks with their bodies." Almost as harmful to the wheat crop as the chinch bug is the Hessian fly. The eggs are laid in the leaves of the wheat. The larvæ attack both the root and the stalk.


Chinch Bug.

The grape phylloxera is a very destructive insect that stings the roots and sucks the juice of grape vines. Another harmful insect is the plum curculio, which lays

its eggs in the green fruit. From these eggs the young hatch and feed upon the plums, which soon drop off. There are many other insects injurious to vegetation, for an account of which the student is referred to the books and pamphlets listed at the end of the book.

Let each pupil bring into class all the above-named insects he can catch.

**70. Insect Control.**—Biting insects are exterminated by spraying the foliage with poisonous mixtures so that the insects take the poison in their food. Sucking insects are destroyed by actually being hit by the spray. Good standard insecticides for biting insects are Paris green and London purple. For sucking insects, the most common remedy is a kerosene emulsion. This closes the breathing pores so that the insect is smothered. Formulas for the various insecticides will be found in the Appendix. These liquids are applied with a spray pump made for the purpose. For the codling moth spraying is sometimes done as many as five times with a combination of Bordeaux mixture and Paris green. The first spraying is done as soon as the petals have fallen, the second three or four weeks later, and the third about nine or ten weeks after the petals have fallen; the fourth and fifth at intervals of two or three weeks. It is often necessary to hand pick or dig out insects.

Insect enemies may be greatly diminished in number by carefully collecting and burning all rubbish, such as fallen limbs of trees, twigs, and stubble. Eggs and the wintering insects may be hidden there, and the burning will destroy them. Neatness then brings its own reward.

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Prepare some kerosene emulsion and Bordeaux mixture according to the formulæ in the Appendix and try them where needed.

**71. Nature of Plant Diseases.**—The third great enemy of the farmer's crop is disease. Plant diseases are caused by bacteria, molds and fungi, organisms that belong to a group of low vegetable forms which, not having chlorophyll in their cells, are obliged to get their food from some higher plant.

These low forms grow mostly from spores, which take the place of the seeds of higher plants; sometimes they propagate by dividing into two or more parts. These spores are very small and innumerable, and are light enough to be carried by the wind. Familiar evidences of these lower plants are corn smut and wheat rust. When broken, the corn smut, as is well known, sends out a great cloud of brown dust; each particle of this dust is a spore, which may produce other corn smut. Because of the vast number of spores, these organisms are multiplied or propagated with great rapidity.

The leaves of gooseberries in the spring may often be seen to have light yellow spots on them. These spots are "rust" and are the result of these spores. The white coating on the surface of lilac and pea leaves is a familiar example of mildew.

**72. Some Common Diseases and Their Treatment.**—Some of the most familiar plant diseases are the fire blight, oat smut, potato scab, potato blight, peach curl, black knot, and fruit mold.

The fire blight gives to the end of apple and pear tree twigs the well-known blackened appearance. It is

caused by bacteria growing in the inner layer of the bark. The twigs should be cut off and burned.

The oat smut is a fungus which does much damage to the oat crop every year. It is said that ten to forty

*a* *b*

*a*—Five Heads of Clean Oats. *b*—Five Heads of Smutty Oats. Note the black smut in the grains and the small size.

per cent of the crop is annually ruined by this disease. In the spring when the seed oats are planted minute spores of the oat smut are sown with them. The smut spores begin to grow about the same time that the oat seed does. They form very small threads—smaller than a cobweb—down in the ground. You have noticed such threads when mold grows on bread. The little threads enter the young oat plants, the sap of which they use for their food and grow rapidly. The plant is weakened by furnishing food for all these threads that run through its roots, stem and leaves. When it is ready to blossom and form oat seeds, the fungus is ready to produce black spores. The ends of the threads grow out on the head of grain and give rise to immense numbers of minute, black spores. The oat plant has not had a fair chance and it will produce few oat seeds as a result. If the farmer cuts the oat plants and carries them to his barn, there will be millions of these spores among the grain. Some of them will be mixed with the good oats and when sowed the next spring will produce the same or worse results. If, however, the oats that are to be planted are soaked for twenty minutes in a weak solution of formaldehyde, made by pouring one pint of formaldehyde into a barrel of water, the smut spores will be killed and the oats will not be injured. They will be just as good for planting but must not be fed to stock after being soaked in the formaldehyde.

The mildew that attacks grape vines consists of fine threads similar to those just described. It can be largely prevented by spraying the vines with the Bordeaux mixture.

Potato scab, familiar to all farmers, is caused by a fungus that grows from spores on the seed potato or in the ground. The remedy is to soak the seed potato in the formaldehyde solution. If the ground has produced potatoes for some time and the spores are in the ground, this remedy will not work and the crop should be grown elsewhere for a period of years. Potato blight affects the leaves and travels from the leaves and stems down into the tubers, causing them to rot. It may be controlled by spraying with Bordeaux mixture.

Prepare the formaldehyde mixture and treat some scabby potatoes and smutty oats. Plant some small patches with the treated seeds and others with the untreated seeds, and see whether there is a difference in the product.

Mixtures for destroying fungi are called fungicides. Directions for preparing and using fungicides may be found in the Appendix.

## SUMMARY

A weed is any plant that grows where it is not wanted.—Weeds are enemies because they absorb moisture and take the plant food needed by the crops.—Weeds, like all other plants, are divided into annuals, biennials, and perennials.—Annuals and biennials may be destroyed by preventing their going to seed.—Perennials must be dug up and destroyed from the roots.

Many kinds of insects do serious harm to plants.—It is in the caterpillar or larval stage that insects generally destroy vegetation.—Insects are classed as cutting and sucking insects.—The cutting insect eats off leaves; the sucking insect takes the juice of plants.—Insects may be destroyed by spraying with poisonous mixtures or various other liquids.

Plants are subject to diseases in the same way that animals are.—Plant diseases are called mildews, scabs, molds, and smuts.

—These diseases are controlled by cutting off and burning the diseased parts and by spraying with various solutions.

## QUESTIONS

1. Why is it more difficult to exterminate a perennial weed than an annual?

2. Name some of the worst weeds. Are they annual, biennial, or perennial?

3. Why are Canada thistle and dandelion hard to keep in check?

4. Name a half dozen injurious insects.

5. Which is it better to kill, a moth or a grub? Why?

6. How does a blight injure a plant?

7. Why should the dead vegetation around a wheat or oat field be burned?

8. Why will not Paris green kill sucking insects?

9. Is it better to let the windfalls from apple trees lie on the ground or should they be fed to some animal? Why?

10. Which is the better farming, to prevent weeds or to kill weeds?

11. Is it good practice to allow weeds to cover the ground after garden crops are gathered? Why?

# CHAPTER IX

## THE FARMER'S FRIENDS: BIRDS, TOADS, INSECTS

**73. Birds and Their Food.**—While a large part of the farmer's work consists in fighting insects, weeds, and other injurious things, he has some valuable friends who work with and for him. Probably the most valuable are the birds. They aid the farmer by eating insects and seeds of weeds. To some extent they eat injurious animals, such as mice and gophers.

Young birds grow rapidly and require a great amount of food. Many of them are fed mostly on insects. It has been estimated that a pair of sparrows will carry more than three thousand caterpillars to their nest in a week. A young robin kept in captivity was fed sixty earthworms a day, and an observer claims that a pair of young European jays were fed a half million caterpillars in a single season. Professor F. H. King, in observations made in Jefferson County, Wisconsin, and in Ithaca, New York, counted on an average thirty-three birds per mile in Wisconsin and fifty-seven per mile in New York. It is probable, as he says, that this number represents not more than half of those occupying each square mile. Is it not evident, then, what a great and constant help the birds are to the farmers?

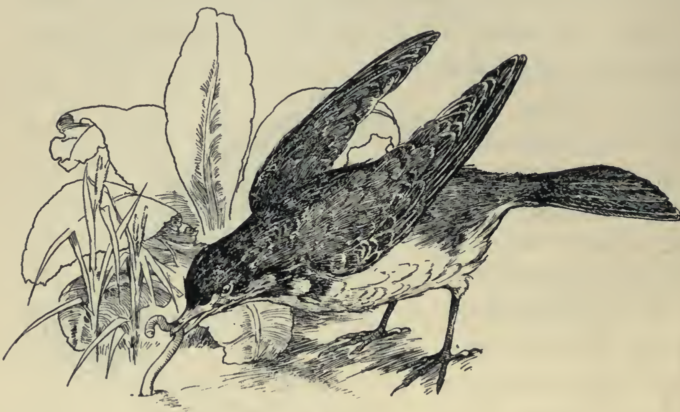
**74. Useful Birds.**—Birds that help the farmer may be divided into three groups: First, those that live chiefly, or prefer to live, upon animal food, such as insects in their various stages. Among these birds may be mentioned the robin, thrushes, bluebird, kinglet, scarlet tanager, bobolink, kingbird, pewees, black-billed cuckoo, and woodpeckers. Second, those that eat both animal and vegetable food. Among these may be mentioned the catbird, brown thrush, white-bellied nuthatch, chipping sparrow, marsh robin, and purple grackle. Third, those that prefer a vegetable diet of seeds. Among these may be mentioned the finches, thistle bird, and indigo bird. It is not to be understood that hard and fast lines can be drawn among the birds in regard to their food. Birds have their preferences, but the season of the year and the abundance or scarcity of a given food determine to a large extent the kind of food eaten.

KINGBIRD.

The robin is a diligent seeker for caterpillars, cutworms, white grubs, and earthworms in lawns, fields, and meadows. In early morning and late evening, this bird may be seen awaiting its prey. All of a sudden it darts

its bill into the ground and brings up a worm. The robin eats caterpillars also, and other larvæ feeding upon shrubs and vines.

The thrushes spend most of their time in thickets and trees, and some observers have consequently



Robin.

thought that they eat buds. An examination of the stomachs of numbers of thrushes, however, has indicated that seventy to ninety per cent of their food is ground-infesting insects and larvæ.

The bluebird catches its prey either on the wing or on the ground, thus taking a wide range in its feeding. It comes early in the spring, rears two or three broods of young, and for their food destroys an immense number of insects. The bluebird seems to like cultivated fields and the society of man, and thus its activities are in an especially useful place.

The scarlet tanager is a beautiful bird that inhabits

the border of woodlands and, to some extent, orchards. From the woodlands it makes excursions into the adjacent fields to capture insects. Although it eats cherries, its useful work fully offsets the damage it does.

Wood Thrush.

The woodpeckers and their habits are well known. These birds spend their time seeking the larvæ hidden in the crevices and under the bark of trees. The golden-winged woodpecker gets its food both from the trees and from the ground, its favorite food being ants. Most of the woodpeckers undoubtedly are beneficial, although

sometimes they may do some damage by eating useful insects.


Downy Woodpecker.

The catbird, because of its fondness for fruit, is not to be ranked among the most useful birds; but it is generally agreed that it does more good than harm. Its

haunts are the underbrush and brambles, which are good hiding places for larvæ, and upon these it lives during much of the year. During the breeding season the song of the catbird is not to be despised, being somewhat similar to that of certain of the thrushes, whose relative it is.

The nuthatches follow after the woodpecker, and extract the small insects in crevices of the bark of trees. They are very lively and seem to be constantly eating, so that they make up in diligence and appetite what they lack in size.

The sparrow, the most common of all our birds, is generally considered a seedeater, being very fond of weed seeds of all kinds; but with the exception of the English sparrow, all sparrows feed mainly on insects in the spring and early summer, and the young are fed almost entirely on insects. The English sparrow is the only real pest in this family.

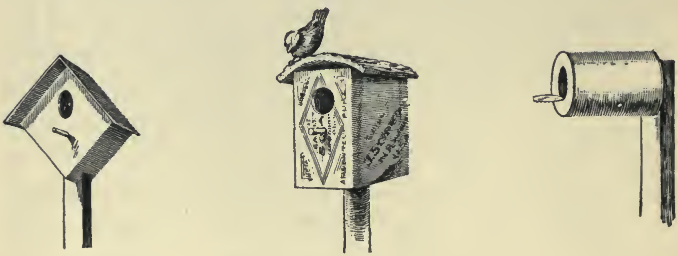
The finches have strong bills adapted for removing the hard shell of seeds. They, together with other birds of their class, devour immense quantities of the seeds of weeds.

The Baltimore oriole eats grapes in their season, but it also does good by eating the pupa of certain insects which do much damage to trees. It is probable that the benefit is much more than the damage.

The meadow lark, killdeer, and plover, during their stay in the North, feed almost entirely upon insects. Even birds of prey do some good by destroying some small animals that are injurious to plants, such as field mice.

Watch the various birds and learn their feeding habits. It is often possible to get into a position where the feeding of the young may be noted.

**75. Attracting the Birds.**—In order that we may have more birds living about our homes, to help destroy insects and give us pleasure by their songs and beauty, we must provide them with conditions which are favorable to their ways of life. Birds must find suitable places for building their nests. The planting of trees and shrubs is the very best way of attracting birds. Clumps of shrubbery will afford excellent nesting places for shy birds, while the crotches of trees will be used by



*a* *b* *c*

Bird Houses. *a* and *b*, made from boxes; *c*, made from a tin can.

robins and many others. The boys can easily make bird houses for wrens, martins, bluebirds, and chickadees. These birds do not care for fancy houses—old boards are better than new ones for building the houses. Wrens will often occupy a tin can or a small pail which has been fastened to a board with the closed end up and a small hole made in the side. This opening should not be over an inch in diameter for wrens; then the English

sparrow cannot enter to trouble them. Old branches that have knot holes of some depth may be fastened on posts, and will often attract bluebirds or chickadees. The barn swallows should be allowed to nest in the barn. If the barn door is kept closed it is a good plan to leave open a small window, or even to make a few holes so that the birds may come and go freely.

Materials may be supplied for nest building. Robins and orioles often spend much time searching for threads and strings suitable for use. Narrow strips of cloth will be used in the nest by them and by some other birds, as thrushes and catbirds. It is always interesting to watch the birds as they come to the shrubs to gather these strings and strips of cloth, to see how they will pull them free from the branches and carry them in their bills to their nests. If mud can be supplied it will also help the robins in their nest building.

Singing while His Mate Builds.

The matter of food supply is a more pressing ques-

tion with the birds than with human beings, for they cannot store away food to any great extent. During the summer days there are insects in abundance and often seeds and fruits. As a rule the birds prefer the wild fruits if they can find any near their nests. In the winter the birds that remain have difficulty in finding food. Then it is that a piece of suet or other fat meat fastened to a tree, or some cracked nuts placed in a shallow box on a tree, will serve to call the chickadee, nuthatches, hairy woodpecker, downy woodpecker, brown creeper, blue jay, and English sparrow. Often during the breakfast hour a score of these birds are seen eating from the suet placed on a tree near the dining-room window. Many of the number are English sparrows, but the other birds come regularly and take their turn also. It is just as necessary, also, to supply coal-ashes or sand, which furnish mineral matter required by seed-eating birds to grind their food. By feeding these birds, more of them will come in the winter, and they eat great numbers of insect eggs and pupæ which have been hidden in the cracks on the bark of trees. This makes a lessening of the insect pests the following summer.

Water is essential to bird life. Often our feathered friends suffer in the summer time because they cannot readily find places to drink and bathe. It is an easy matter to place a pan or shallow dish partly filled with water on a post out of reach of cats. Most of you will be surprised at the number of bird visitors that will come every day to seek a drinking fountain.

If the stray cats of the neighborhood can be disposed

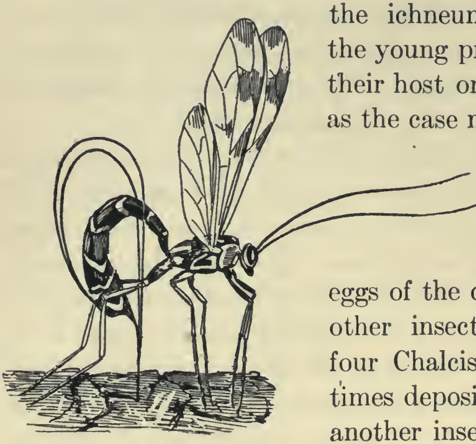
of this will serve as a very valuable way of increasing the number of birds about our homes. Pet cats often catch birds, even pet cats with bells fastened around their necks will catch and eat young birds. The homeless cats eat large numbers of birds every year and should be disposed of. Children should be taught to care for the birds and not to molest them.

**76. Toads and Frogs.**—The toad can lay no claim to beauty, but there is no more useful animal of its size. One of the most amusing pastimes is to catch rose bugs and put them down in front of a toad. The bugs suddenly disappear. The toad's tongue is attached at the front of its mouth. It is covered with a sticky substance, and can be snapped out like a whiplash. There seems to be no limit to the number of bugs a toad can eat, so that toads exert a great power for good in ridding our gardens of destructive insects. The eggs of toads are laid in the water, in strings of a jelly-like substance. The tadpoles that are hatched from the eggs are useful in devouring the refuse matter in the pond. Frogs perform the same service.

**77. Useful Insects.**—You might think from the last chapter that all insects are enemies of the farmer, but such is not the case. There are many insects which help him greatly by destroying other harmful insects.

One of the useful insects is the ichneumon fly, distinguished by having bristles at the end of the abdomen, sometimes several inches long. These are for the purpose of placing the eggs and serve also as a drill for piercing whatever the eggs are to be placed in. There

are several thousand varieties of ichneumon flies. They lay their eggs in the eggs, larvæ, or pupæ of other insects, or in crevices where other eggs are laid. When the ichneumon eggs hatch, the young proceed to feed on their host or their neighbors, as the case may be.



Ichneumon Fly Piercing the Bark of a Tree.

The Chalcis flies are minute insects that lay their eggs in the eggs of the codling moth and other insects. As many as four Chalcis eggs are sometimes deposited in one egg of another insect, which is thus destroyed when the young hatch and feed on it.

Ladybugs are bright-colored beetles that feed on plant lice, the eggs often being laid in the midst of a cluster of the lice. The ladybug was recently in great

Caterpillar, Showing the Holes in its Skin from which the Ichneumon Fly Parasites have Issued.

demand to destroy the "green" bug in the wheat fields of Kansas. Lion and tiger beetles, as their names would

indicate, prey upon other insects, such as caterpillars and earthworms.

Dragonflies and damsel flies, with their beautiful gauzy wings, are familiar over stagnant pools, where they are beneficial in catching flies and mosquitoes. Their eggs are often laid under water. The larvæ live in water, and even in the pupa stage they feed on water insects and small tadpoles.

Watch the animals and insects mentioned and notice their habits.

## SUMMARY

Birds are among the farmer's most useful friends.—If it were not for birds, insects would probably strip the earth of vegetation.—Birds may be divided into those that live chiefly on animal food, those that live chiefly on vegetables, and an intermediate group.—Insects are the natural food of many birds, especially young birds.—Vegetable feeders help the farmer greatly by eating seeds of weeds.—Many birds that eat fruit during a small part of the year more than make up for such damage by eating insects at other times.

Much may be done to make conditions better for the birds, so that more will come to live with us. Bird houses are easily made, and food may be supplied in the winter months to induce more birds to remain in the vicinity.

Toads and frogs destroy many insects and should be protected.

Many useful insects prey on the harmful insects and so help to diminish their number.

## QUESTIONS AND PROBLEMS

1. If insects lay as many eggs as they are said to, why do they not become more numerous?

2. What are the three groups of birds, according to their choice of food?

3. In what season of the year do birds destroy the greatest number of insects?

4. What is the difference between a toad and a frog?

5. Counting 40 birds to the square mile, how many birds are there in your State?

6. Allowing each bird 50 insects a day for the 120 days of summer, how many insects are destroyed during the summer?

7. Three golden-winged woodpeckers were found by King to have in their stomachs, respectively, 255, 220, and 200 ants. Supposing this to represent one day's ration, how many ants would these three birds eat in four months?

8. During an outbreak of Rocky Mountain locusts a marsh wren was seen to carry 30 locusts to her young in one hour. At this rate, how many would she carry in 7 hours?

9. If there were 20 broods being thus fed, to the square mile, how many insects would be destroyed in the 78,000 square miles of Nebraska's area?

10. Each locust in Problem 9 weighs 15 grains and there are 7,000 grains in a pound. If each locust would consume its own weight of standing crops each day, how much would be saved by the birds, allowing $10 per ton for the crops?

# CHAPTER X

## PROPAGATION OF PLANTS BY SEEDS

**78. Seeds.**—Already you must have realized that seeds are very important. You have learned how the plant starts its growth from the seed, feeding at first on the nourishment stored there (Sec. 2). As the production of seed is the object of the plant's existence (Sec. 58), let us see now how the seeds are produced.

**79. Flowers.**—We may regard flowers as the first stage in the production of seeds. Many plants, of course, are raised solely for the beauty of their flowers; but if the blossoms are unpicked you know they will "go to seed." Other plants have flowers which we hardly notice, for we are interested only in the grains or fruits that grow from the blossoms. For example, the ear in its early stage and the tassel of the corn plant are really its blossoms. The flowers of the berry plants and fruit trees are familiar. The elm, the maple, and other trees also have flowers, although you may never have looked closely enough to see them in the spring.

**80. The Parts of a Flower.**—In order to see where and how the seed is produced, we must take a flower to

pieces and learn its parts. You will notice first a sort of cup where the flower rises from the stem. This is the *calyx.* It is sometimes slit into parts, like little leaves, which are called *sepals.* The sepals of most flowers are green. Inside this green calyx cup is a row or cluster of snowy white or colored leaves, or *petals,* forming the *corolla.* This is generally the pretty part of the flower which attracts our attention. In the heart of the flower you will find a cluster of slender threads, called *stamens.* At the tip of each stamen is a knob, containing at a certain time of the year fine powder. This fine, powdery substance is called *pollen,* and the knob is the *anther.* There is still one more part of the flower to notice—the part for which the other parts exist. At the very center of the flower is the *pistil,* the seed organ. Often there are several or many pistils. At the top, the pistil is enlarged a little to form what is called the *stigma.* The base of the pistil is the *ovary,* and there the seeds are formed. The part connecting the ovary and the stigma is called the *style.*

Some flower of the rose family may be taken to learn these parts. To this family belong the apple, pear, plum, cherry, strawberry, raspberry, blackberry, and roses, so it will be easy to obtain a specimen. Let us take the strawberry. The calyx will be found to have five parts, and outside of these are five other leaflike parts called *bracts.* Five white petals next appear, and inside of these are the numerous stamens, each bearing at the top its anther. In the center of the flower are found the pistils, which are numerous and gathered in a clump or head. Sometimes we find strawberry or other

blossoms which lack either pistils or stamens; such blossoms are said to be *imperfect.*

Not every blossom contains all these parts. Some plants have no sepals or petals on their blossoms. Cer-


DEVELOPMENT OF THE PEAR. *a*, branch of the tree, showing flowers; *b*, section of flower, showing parts; 1, calyx, showing sepals; 2, corolla, showing petals; 3, stamens; 4, stigmas; 5, styles; 6, ovary, showing seeds; *c*, ovary developed into the pear.

tain other plants have stamens and pistils on some of their blossoms, but not on all. Sometimes the stamens are on one blossom of a plant and the pistil is on another blossom of the same plant. Most flowers do not have bracts.

Examine flowers carefully until you can easily distinguish the parts.

**81. Pollination.**—In order that the seed may be formed in the ovary, it is necessary that pollen shall fall or be placed on the stigma. At the season of the year when the pollen is ripe, the stigma is in just the right condition to receive it, that is, the stigma is sticky and the pollen will adhere to it. The grain of pollen on the stigma sends a shoot down through the style into the ovary, where it reaches the forming seed or ovule, as it is called, and *fertilizes* it, so that it will grow to a live seed able to sprout and produce a plant. As the anther containing pollen and the stigma (the top of the pistil) are frequently close together, it looks like a simple act for the pollen to fall on the stigma. But we have just learned that stamens and pistils do not always grow together in the same blossom or even on the same plant. How, then, do you suppose this fine, almost invisible, powder can be carried from one plant to another?

The breeze wafts some pollen and distributes it to stigmas; but there is another and surer way. Bees and other insects flying from flower to flower are the chief means of pollination, that is, of transferring pollen from anther to stigma. When they alight on a blossom they

may brush on their body some of the pollen and when they visit the next blossom this pollen may rub off on the stigma. The visits of insects are, therefore, very necessary to the flowers if good seeds are to be produced. To attract them the flower has several devices—its bright color and its sweet perfume, its whiteness and its nectar. The insects always seek the sweet substance which is generally found deep in the cup of the blossom, and in probing for it they unawares do their special service for the plant.

A Bee Gathering Honey, and Showing How the Pollen can Rub Off on Its Body and Legs.

82. **Cross Pollination and Hybrids.**—The pollen must unite with the ovule in the ovary in order that fertile seed may be produced. This grain of pollen may come from the same blossom or from that of another plant of the same kind. When the pollen from one plant enters the ovary of another to produce seed, we have what is called *cross pollination*. The seed that results from cross pollination may produce a better plant than either of the original or parent plants. The characteristics of the two parents are united in it. In this way new varieties of plants may be formed.

Sometimes we combine the characters of two kinds in a new plant. Such a plant is called a *hybrid*. Two varieties of apples may be crossed in this way. In such

cases pollination is not left to the chance of wind or bees, but the crossing is done by hand. The qualities most desired in a plant can sometimes be obtained by selecting carefully the two parents of a seed.

When pollination is done by hand the anthers of one flower are removed with forceps or scissors before the flower opens and the flower inclosed in a paper bag tied around the stem. When the flower opens and the stigma is ready to receive the pollen, this is obtained from another plant and applied to the stigma of the first flower with a small brush or even with the finger. The flower is then covered again with the paper bag, which may be replaced with a gauze sack after the fruit is set. Dozens and even hundreds of flowers may be thus pollinated in an experiment and the seeds planted and allowed to develop to see whether they will produce improved plants.

Agricultural experiment stations and private investigators have secured remarkable results in crossing plants. Among the most noted plant breeders may be mentioned Luther Burbank, of California, who has produced some unusual fruits and plants. One of these is the Wickson plum, produced by crossing the Burbank and the Kelsey plums. It combines the best qualities of both its parents, having the shape of the Kelsey and being of a delicious juicy quality. A hybrid made by crossing the apricot and the plum is called a *plumcot* by its originator. White blackberries, seedless apples, and stoneless prunes are other of Mr. Burbank's creations.

**83. Propagation of Plants.**—The farmer, however, is less directly concerned with these special matters of

pollination than with the simple production of plants, that is, propagation. If no one looked after the planting of seeds and the raising of plants after the seeds sprouted many varieties would disappear entirely. Most plants die after a few years; and even those which, like the great trees of California, live to be many hundred years old, will eventually die. The farmer makes it his business to see that, as the old plants die, new ones are raised to take their place. The chief work of the farmer, indeed, is the propagation of plants.

84. **Quality of Seeds.**—You know that the quality of seed affects the kind of plant that will result. The farmer can get a weak plant or a strong plant, few fruits or a generous crop, according to the qualities of the seed he plants. There are several factors which determine whether the seed will grow well—its age, its maturity, the vigor of the parent plant, and the conditions (moisture, air, and warmth) of the soil in which it is planted. Some seeds will not sprout owing to age or other unfavorable condition. Those that will sprout are said to be *viable.*

85. **Age of Seeds.**—Melon seeds will grow when ten years old. Onion seeds frequently will not sprout if they are more than a year old. Starchy seeds, as rice and wheat, seem to remain viable longer than oily ones, as corn and sunflower.

The following table from Vilmorin's "Vegetable Garden" gives the average period of viability:

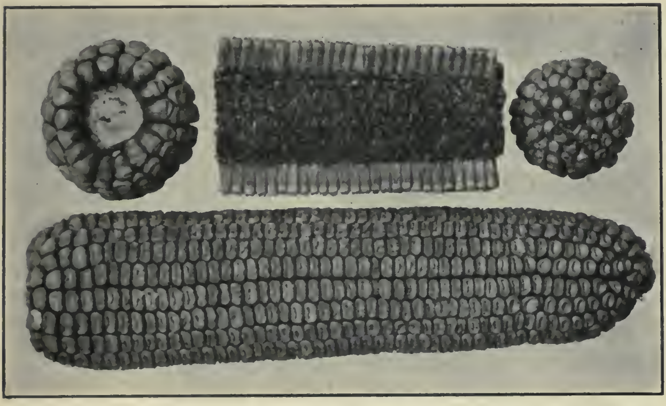
Duration of Germination Power

| | Average Years | Extreme Years |
|---|---|---|
| Beans | 6 | 10 |
| Bean, kidney | 3 | 8 |
| Beet | 6 | 10 |
| Cabbage | 5 | 10 |
| Carrot | 5 | 10 |
| Cucumber | 10 | 10 |
| Lettuce | 5 | 10 |
| Maize | 2 | 7 |
| Melon | 5 | 10 |
| Onion | 2 | 7 |
| Parsley | 3 | 9 |
| Pea | 3 | 8 |
| Squash | 6 | 10 |
| Tomato | 4 | 9 |
| Turnip | 5 | 10 |

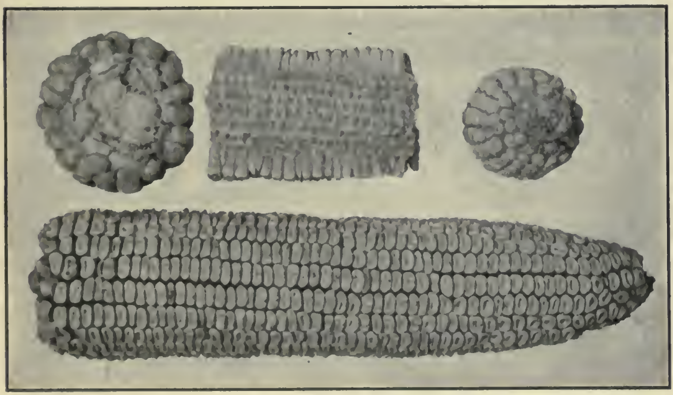
**86. Maturity of Seeds.**—Another condition that affects the quality of seed is the time when it is taken from the parent plant. If the seed is ripe, or fully grown, we say that it is *mature*. Some seeds will not sprout, or germinate, if picked too soon. Other seeds will continue to ripen after leaving the plant, especially if a part of the plant is gathered with them. And there are some seeds, as the tomato, that will germinate if the fruit is but little more than half grown.

It is thought that if immature seeds were used for several generations, it would result in reducing the vigor of the plants. Seeds should be kept in a dry place after being matured to prevent deterioration.

**87. Selecting Seeds.**—By careful selection of seeds much better crops may be secured and plants may be



Two Ears of Corn, Showing Desirable Qualities for Selection.



Two Undesirable Ears.

improved in many ways. Great improvement in corn, wheat, and other grains, as well as in many other kinds of plants, has been made and this is largely the result of seed selection. It is not sufficient to select the seed

after it has been harvested; useful selection reaches back to the growing crop. In brief, the selection of seed corn is as follows: The farmer or breeder gets clearly in mind his ideal. Early in the fall before the time of harvesting he goes through the field and selects the stalks of superior quality. In this selection he takes account of the general vigor of the stalks, width of blade, shank of ears, neither too long nor too short, ears at an average height from the ground, number of ears on stalk, strength of brace roots, size and regularity of the stalk. Then he closely inspects these selected plants again, and chooses the ears that most nearly meet the ideal he has in mind. The corn from these ears is planted, the kernels from an ear of one stalk in one row and those from an ear of another in another row, and selections are again made just before the harvest. Seed is taken this time from those rows and plants that show the best results in conforming to the ideal. After several years of such selection and planting a certain type will become fixed. Sometimes the corn from one ear is planted apart from others in a square patch instead of in a row, as there is then less danger of corn from different types of ears mixing by the pollen blowing across.

Sometimes it is desirable to change even the content or composition of the seed corn. In this case analysis is made of the kernels from selected ears to determine the relative amounts of proteid, oil, and starch, and selections made accordingly. By this means corn has been made to vary from 2.62 per cent to 6.98 per cent in its oil content, and from 6.98 per cent to 14.13 per cent in protein. Of course not all the good qualities

can be readily obtained in one type. If earliness is sought size may be sacrificed, and if size is the main quality sought time of maturity may be sacrificed. So also, if great size is desired numbers may need to be sacrificed. Very expert work is required to produce the proper combination of good qualities; and even then the results may be disappointing.

Select an ear of corn from a stalk bearing two ears, and one from a stalk bearing one ear. Plant some kernels from each some distance apart, and mark the rows for identification. Note whether one kind produces stalks with two ears each.

Among the small grains it is well to select those that are able to resist drought and smut, those that are early, plump, and will yield abundantly. It will be no great trouble to sow these in a part of the grain field for several successive years, and a better lot of seeds may thus be obtained. The variety of wheat known as bald wheat was produced in this way by a thoughtful man who accidentally discovered three heads of bald wheat in a field of bearded wheat. This was the famous Fultz wheat, now one of the best varieties in either America or Europe. England produces nearly twice as much wheat to the acre as the United States, partly because of more careful selection of seed.

The Burpee bush lima bean was developed from one hill of pole beans which had withstood a frost that killed all the rest of the beans in the field. This one hill produced beans on a dwarf vine. These beans were planted, and seeds were selected from the smallest vines until the variety was established.

SUGAR BEETS. This pile represents ten tons of sugar beets grown on two fifths of an acre of land at the Experiment Station Farm at Madison, Wis.

TWENTY-THREE HUNDRED-POUND SACKS OF GRANULATED SUGAR. This is the product of the ten tons of beets in the picture above. The University received a check for $44.32 from the Wisconsin Sugar Co. for this shipment. This is at the rate of $110.80 per acre.

By selection of seeds of sugar beets, the amount of sugar contained has been increased from about seven per cent in the original beets to as high as twenty per cent in some types. The average in the best sugar-beet countries is about sixteen per cent. In order to make the selection in this case, a small part of the beet is cut out and analyzed to determine the amount of sugar. Seeds are then raised from the beets which show the most sugar. The small piece cut out of the beet does not injure it for producing seed.

A CONVENIENT SEED TESTER FOR FARMERS.
Courtesy of Agricultural Experiment Station, Madison, Wis.

**88. Testing Seeds.**—Careful farmers generally test seeds before planting. By taking a hundred seeds as

samples and letting them sprout in a seed tester the farmer can judge of the viability of the seeds he is about to plant. If a quarter of these sample seeds do not sprout, he knows what may be expected of the whole. It is better to find this out before the seed is sown.

A convenient form of tester is a tin pie plate with a flat cover, or two pie plates put together. Two pieces of cotton flannel, or similar cloth, are cut the size and shape of the tester. These cloths are wrung out in warm water and one of them is placed in the bottom of the plate. One hundred seeds are counted and placed upon the wet cloth and are covered by the other cloth, which is pressed down. This is then covered by the other plate and placed in a warm place. Two or three matches may be placed on top of the upper cloth to prevent mold. The cloths should be kept wet and the seeds examined from day to day. The number that sprout is the percentage of good seeds; that is, if sixty seeds sprout in the lot selected, we may consider that sixty per cent of the whole batch are good.

Test some seeds by the method described in Sec. 88. If you take 50 seeds instead of 100, the percentage is found by multiplying by 2 the number that sprout. Why?

**89. Conditions Affecting Germination.**—If the seeds are to sprout and grow well, there are several conditions which must be favorable, such as depth of planting, fine seed bed, moisture, air supply, temperature, and nature of seed case.

The size of the seed determines to a large extent the depth of planting. Small seeds that produce weak

plantlets must be left near the surface of the ground. Many of the garden seeds should not be planted more than half an inch deep. Peas are sometimes planted several inches deep, so that they will not suffer from drought.

In order that seeds may germinate they must be able to absorb moisture. They will do this better if the soil is compacted over them. The danger in this is that a crust is thus formed which the young plants must break through. The soil must not be too wet or the seeds may rot before they sprout. If the soil is too compact or too wet the air will be kept from the seed. This will hinder germination, because the seed must have plenty of air. In fields which are under water soon after planting, the seeds do not sprout.

There is a certain temperature which is best for the sprouting of plants. If the soil is colder than this the seeds will not sprout, or will sprout but slowly.

Some seeds, as nuts, have so hard a seed case that something must be done to help release the sprouting plant or it will not germinate. These shells are often hand-cracked or allowed to break by freezing and thawing before planting.

## SUMMARY

All plants have flowers.—The most important parts of the flower, as regards plant reproduction, are the ovary and the pollen.—Pollen must fall on the stigma and penetrate through the ovary to the seed in order to make possible the growth of the seed.—The sprouting of the seed depends on its age and maturity, vigor of the parent plant, and the condition of the soil.

Seeds should be carefully selected and tested.—They should be selected early, from the growing plant, not after harvesting. —Different seeds should be planted at different depths, according to the size and kind.

## QUESTIONS AND PROBLEMS

1. Why are plants propagated?

2. What is meant by seed selection?

3. Why is selection necessary?

4. What is the use of the pollen?

5. How may bright colors of the flower or strong odors be useful to the flower?

6. What are the conditions that affect germination?

7. The annual wheat crop of the United States is about five hundred million bushels. If this could be increased 2 per cent by seed selection, what would the addition be worth at 80 cents per bushel?

8. How many agricultural experiment stations would the increase support, at half a million dollars a year for each station?

9. If grass seed costs 10 cents a pound and is 20 per cent weed seed, what is the real cost of the grass seed? Would it be cheaper to buy a clean seed at 12 cents?

10. If one day extra were spent by every farmer each year for five years in selecting and caring for seed corn, and the yield thereby increased 100 bushels, would it pay?

11. It costs about $30 to grow an acre of sugar beets. What would be the profit per acre of beets grown under conditions similar to those in the illustrations on page 114?

## CHAPTER XI

### PROPAGATION BY CUTTINGS AND OTHER MEANS

**90. Other Methods of Propagation.**—In propagating by seeds we produce new plants by putting into the ground parts of the parent plant specially ordained by nature for this purpose, without injury to the parent. Another method of propagation is by cutting off a part of the parent plant and letting that grow separately. These removed parts are spoken of as *cuttings*, and the process is known as propagation by means of cuttings. In other cases a part of the plant may take root and grow into a new plant without being entirely separated from the parent plant. This is done by bending down a branch and covering it with soil; it is called *layering*. In still other cases, plants may be propagated or established plants entirely changed in many of their characteristics by *grafting* and *budding*.

**91. Growth from Buds.**—In these other methods of propagating plants the development of the new plant comes from buds instead of seeds. Every live stem or branch has buds along its sides and one, at least, at the end. When the leaves fall the bud at the base of each leaf remains, and the next spring it opens into new leaves.

With many kinds of plants, if a piece of the stem is

planted in soil, roots will grow from the buds and a new plant will be formed. Some plants, as the strawberry, send out from their main stems runners which end in a strong bud. These buds take root and thus the original plant makes many new ones. One parent may form thirty or forty young plants in the course of a season.

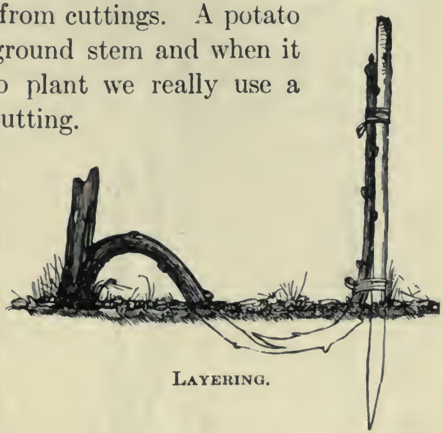
**92. Cuttings.**—To propagate a plant by cuttings, we remove a part of the stem that has at least one good bud. This piece is put in water or moist earth. After its roots are well started, it may be carefully removed to the place where we want the plant to grow.

Many plants are propagated by cuttings. A few, as the begonia, may be propagated from a leaf rooting either in water or in damp sand. But plants are more frequently developed from thrifty shoots. This is the common method with geranium, heliotrope, verbena, nasturtium and others. The shoots or cuttings are divided so that there are two or more joints or *nodes* to each cutting, which is then buried in moist sand and kept warm by artificial heat if necessary. If there are leaves on the shoots they should be trimmed or removed to reduce the evaporating surface. When the roots are an inch or so long, the cuttings may be transplanted into small pots, and from there into larger ones as the roots fill the pots. Hard-wood cuttings, such as currant, gooseberry, grape, and flowering shrubs, are generally made in the fall and packed in green sawdust or damp sand. They may be started in the house by February or March or lie until spring and be planted in well-prepared soil. Each cutting should have two or three nodes, and when planted one node should be above

ground. They are generally put into the ground in a slanting position and the soil firmly pressed about them.

Potatoes, sweet potatoes, and sugar cane are nearly always propagated from cuttings. A potato is a swollen underground stem and when it is cut in pieces to plant we really use a piece of a stem or cutting.

**93. Layering.**—In some plants buds may be made to root without being cut from the plant. A slender branch or stem is bent down then covered with soil. From the buds in this part of the stem roots will grow. When they are well established the stem is cut off below the new roots and we have a new plant.



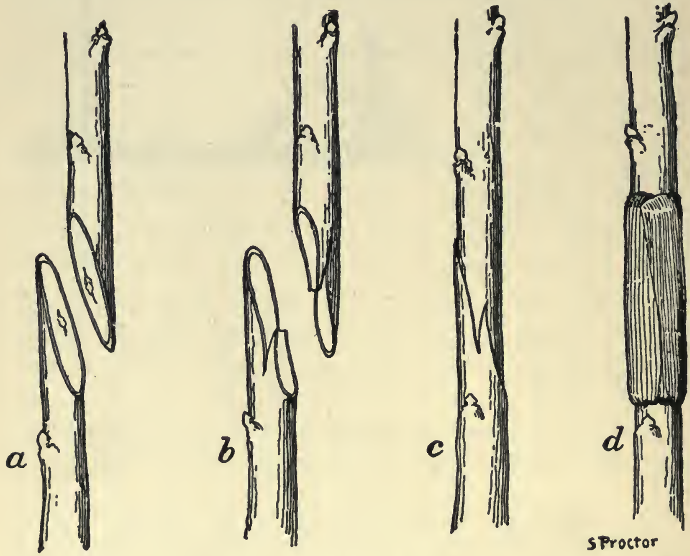
LAYERING.

Try the experiment of layering such bushes as gooseberry, raspberry, blackberry, and currant, and also grape vines.

**94. Grafting.**—Grafting consists in setting into a tree a little twig from another tree, so that it becomes part of the new tree. The tree on which the grafting is done is called the *stock*, and the twig set into it is a *scion*. Grafting is done to secure a different kind of fruit on a tree, to preserve and multiply special varieties, to hasten flowering or fruiting of seedlings, to replace lost branches, or to change the size or shape of a tree. All the fruit trees in America are grown either from buds

or grafts as they do not come true from seed. An apple tree bearing poor apples by successful grafting may be made to bear a good variety. Healthy twigs from a tree bearing the desired fruit are made to grow into and become a part of the poor apple tree.

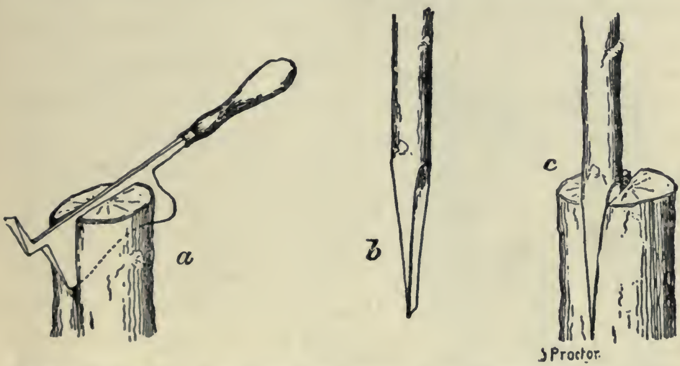
In the case of apple trees, for example, the scions are cut from a desirable tree in the fall and kept in a dry,




GRAFTING. *a*, splice graft; *b*, tongue graft, parts separate; *c*, tongue graft, parts united; *d*, waxed paper applied.

cool place over winter. In the spring they are set into the stock where desired. A small branch, perhaps three quarters of an inch or larger in diameter, is sawed off and the stub split with a knife. The scions are whittled wedge-shaped and slipped into the cleft in the stock.

In this way stock and scion are spliced. Just under the outer bark is a thin, soft layer called the *cambium*. It is the living and growing part. Care must be taken to have the cambium layer of the scion come in contact with




CLEFT GRAFTING. *a*, splitting the stock; *b*, scion prepared for insertion; *c*, scion inserted.

the same layer of the stock. The freshly cut parts are then covered with grafting wax to keep out air and moisture. Generally two scions are inserted into one cleft and after they are well started one of them may be cut away.

Root grafting, as well as stem grafting just described, is a common practice.

Get some scions from a good apple tree and practice grafting. Make some grafting wax from the following formula: Melt one part beef tallow, two parts beeswax, four parts common rosin, all by weight. Pour into water, and when it is cool enough work with the hands as with molasses candy. The hands should be greased with lard or vaseline. Make up into rolls and cover with paraffined paper or lay on a piece of glass. When

wanted, it may be placed in warm water to soften. For use in waxing cloth the beeswax may be omitted or one half more tallow used.

**95. The Necessity for Grafting.**—It is necessary to propagate fruit trees and some other plants by budding and grafting rather than by seeds. The trees have not been raised from the seed enough generations to come "true." For example, if all the seeds of a Baldwin apple tree could be planted and come to mature trees, it is possible that one or more of the trees might yield Baldwin apples, but the great majority would produce fruit like their wild ancestor, or at least very unlike the Baldwin from which they came. This is also true because trees have their blossoms fertilized by insects from other varieties of trees and this would tend to produce mixed seeds. A far surer way, therefore, to get what is wanted is to graft from a good Baldwin apple tree. The trees which nurserymen sell are raised from seeds. When the one- or two-year-old seedling is about the size of a lead pencil it is dug up and cut off near the root and a scion from the desired tree grafted into the root part of the seedling. The root may be divided so that three or four stocks may be made from a single root. In some cases dozens of scions are grafted into a grown tree and when they are firmly established the other parts of the tree are cut away so that the entire tree is changed.

Grafting is generally done in the spring just before growth starts. The scions are cut in the fall and kept in a cool cellar so that they will not start growing too early. It would not do to have the scions start to grow

before the branch into which they are inserted is ready to provide sap for them.

Root grafting is generally done in winter and the plants stored as directed for the scions.

96. **Budding.**—The process of budding consists in inserting through the bark of a young tree a single bud cut from another tree. The desired bud is cut off with a sharp knife and is inserted in a T-shaped cleft made through the bark. The wound is then covered with strips of cloth which have been saturated with melted grafting wax.

BUDDING.

In budding and grafting it is necessary that the stocks and the trees from which the buds or scions are removed be closely related. For example, an apple and a crab-apple can be grafted on each other, but not a peach on an apple. Ordinarily grafting is preferred for certain kinds of fruit and budding for certain other kinds. Apples and pears are grafted. Peaches, plums, cherries and apples are budded. All that part of the tree above the bud or graft partakes of the nature of the tree from which the scion was cut.

## SUMMARY

Propagation may be accomplished by means of cuttings, layering, grafting, and budding, as well as by seeds.—In these methods the new plants grow from buds instead of from seeds.—Fruit trees must be propagated by grafting and budding because they do not "come true" from seeds.

## QUESTIONS

1. What two general methods of propagating plants are there? Why?

2. In grafting, why must the cambium layers of the scion and the stock come in contact with one another?

3. How are carnations, roses, geraniums, and begonias propagated?

4. Which is the sure method of propagating fruit trees, from seeds or from grafts? Why?

5. What advantage will a young potato plant propagated from a piece of potato have over a plant grown from the seed?

6. Why is the spring a good time in which to do grafting?

7. Why might a rainy time when trees are in blossom prevent a good crop of fruit?

8. Why is layering a more sure method of propagating than by a detached cutting?

9. Why is the spring the best time for grafting?

10. Why is it best to remove some of the leaves from a cutting or scion?

# CHAPTER XII

## THE FARM GARDEN

**97. The Importance of the Farm Garden.**—In the farm garden can be raised, with little outlay, a great variety of good, healthful food for the farmer and his family. Many farmers have thought they were too busy to attend to a vegetable garden. Many city folks in much poorer circumstances than the average farmer have had a greater variety of fresh vegetables and fruits on their tables than he. But farmers are coming to realize that it is a good investment to set a good table; that it is very important for the health of the family, and especially of the younger members, to have a generous and varied diet, and so of late years the garden has come more and more to be considered an indispensable feature of the farm.

**98. Position and Soil for the Garden.**—The garden should be in a warm, sunny place, sloping to the south if possible, so that the plants may grow rapidly. Most garden crops are better if they make a rapid growth. The best soil for the garden is a light sandy loam (Sec. 8). By proper treatment and cultivation almost any soil can be made suitable. The soil should be enriched with well-rotted manure.

The garden should not be laid out in square beds or little patches as was formerly the practice, unless it is to be taken care of by a gardener. It should be long and narrow, or at least of such shape that things may be planted in long rows and easily cultivated. With this arrangement the garden can be cultivated by a hand wheel cultivator or by a plow or other implement drawn by a horse. Horse cultivation in the garden pays, and if it is to be practiced, the nearest rows should be twenty-four to thirty-six inches apart. The spacing of rows may vary from thirty inches for small stuff to four feet for melons and eight feet for blackberries.

**99. The Care of the Garden.**—One difficulty in the way of having a good garden on the farm is that it must be attended to in the early spring when the farmer is straining every energy to get the main crops started. But the garden is a place where every member of the family can help, and it requires comparatively little labor and time. The soil should be thoroughly tilled in the spring and enriched if need be and a good seed-bed prepared, as we have already learned (Sec. 23). Weeds must be kept out by frequent use of the hoe or cultivator, operations which will also serve to keep air and moisture in the soil (Sec. 22).

**100. Desirable Plants for the Garden.**—The aim in choosing plants for the garden should be to have such a variety that there will be a constant supply for the table from early in summer until late in the fall. It is possible sometimes to plant early vegetables and later ones in alternate rows. The early ones will be out of the way before the late ones need ground to spread over.

In this way, if there is need to economize space, radishes might alternate with parsnips and be out of the way before the parsnips are very large.

A garden should be arranged so that it may be easily cultivated. Everything should be planted in rows; and if the garden is large and a horse is to be used, the closest rows should be from twenty-four to thirty-six inches apart. The distance between rows should vary from thirty inches for small stuff to four feet for melons and eight feet for blackberries.

Among the earliest plants that a garden will yield are lettuce and radishes. Lettuce seed sprouts very easily and quickly. It may be planted in rows twelve inches or eighteen inches apart. The seeds should be covered half an inch deep and the young plants thinned out so that they will be one or two inches apart. For head lettuce the plants should not be left nearer together than about eight inches. Radishes are generally planted in double rows six inches apart and eighteen inches from the next double row of plants.

Beets for early greens may be planted in rows twelve inches apart, but if the roots are wanted the rows should be eighteen inches apart. The seeds should be covered about an inch, and the soil pressed firmly over them. The plants should be thinned out to three inches apart if raised for the tops, and six to ten inches apart for early and late roots.

Peas are planted several times in a season. Small varieties that do not need bushing may be planted in double rows, twelve inches apart and thirty inches from the next double row of plants. "Champions" and

other large bushed peas should be in rows three feet apart. Peas should be planted deep, even as much as four inches.

Sweet corn should be planted at intervals of two weeks up to the middle of July. In this way it is possible to have table corn during a period of six weeks or more. The rows may be thirty or thirty-six inches apart. Some persons plant in hills about the same distance apart each way, and others in drills, the plants eight or ten inches apart in the row.

Bush lima beans and string beans are planted in rows eighteen inches apart, and the plants should be thinned so that there are three or more inches between them. Pole beans are a good crop where poles can be obtained.

Cucumbers and squashes are planted in hills, about three or four plants occupying an area five feet square. The hill should be dug out and several forkfuls of manure should be put in the bottom and then covered with soil. Cucumbers enough for a small family may be raised in the following way: Dig a hole deep enough to bury a barrel; fill the barrel with horse manure; cover it about six inches deep with fine soil, and plant. Allow a half dozen or more plants to grow. Leave the center of the hill open for the purpose of pouring in water. The manure must be kept saturated all summer. A circle ten feet in diameter will be needed for the vines.

Tomatoes are set out in rows about five feet apart and should be kept well cultivated.

Carrots, parsnips, and celery may easily be grown in the garden if desired. Celery for early use is planted in

the house and set out in trenches in midsummer. Later it is banked up with boards and earth to bleach it. For a late crop, it may be started out of doors.

Asparagus is a perennial and must be set out where it will be undisturbed. It takes several years to get a good asparagus bed, but afterwards the plant gives very little trouble. Salt is used as a fertilizer for it. One should cease cutting the asparagus when the stalks come up as small as a lead pencil.

Strawberries, raspberries, blackberries, currants, and gooseberries are grown from plants which are generally bought of nursery men. In setting out a strawberry bed, more than one kind of plant should be chosen in order to secure good results. On some varieties of strawberries the blossoms have no stamens. These plants will not produce fruit unless strawberry plants having perfect blossoms are growing within a few feet (Sec. 80). The strawberry plants are easily taken care of and multiply rapidly. They bear fruit the next season after they are planted. The other berries mentioned are hardy plants and are valuable additions to the farm garden.

The best experiment on this subject is to make and care for a garden. If it is your first attempt, do not try to raise many things. A half dozen things well cared for are enough. Lettuce, radishes, beets, peas, corn, cucumbers, make a good list to start with.

## SUMMARY

The garden is important because it furnishes the farmer a variety of food at little cost.—The farmer should see that the soil is right and should enrich and till it thoroughly.—The depth

of planting the seeds, distance between the rows, and the thinning out of the young plants should have careful attention.—The garden should be started early and planted with such crops as will yield a constant supply all through the summer.—Vegetables should be planted in rows, not in patches, for ease in cultivation.

# CHAPTER XIII

## FARM CROPS

**101. Hay and Grass Crop.**—Probably the most important crop, and certainly the one occupying the largest area in the United States, is the hay and grass crop. Although a very great number and variety of grasses are grown throughout the country, the principal ones used for hay are timothy, orchard grass, red top, and June grass. In addition to these may be mentioned alfalfa and the clovers. No farm crop requires more careful judgment on the part of the farmer.

This judgment relates to the kind of soil suitable, the kind of grass best adapted to his use, the proper fertilizers, the best time to harvest and the proper curing and storing. Scarcely any other crop is so liable to injury in harvesting as the hay crop. Some varieties of grass require a heavy, moist soil, while others will do well on a soil that is dry. If the hay is to be fed to horses it should be coarse like timothy and many would say, free from red clover. Cattle may be fed finer hay and clover. The kind of grass will also determine the kind of fertilizer to be used. Land fertilized heavily with barnyard manure will produce a good crop of timothy, while, if clover is desired also, it is a good plan to substitute

muriate of potash for some of the barnyard manure. The time to harvest hay depends upon the kind and the use to which it is to be put. Timothy should be allowed to mature, while some others are cut before maturity. While the temptation is to dry the cut grass quickly by constant stirring and exposure to the sun, the best authorities now advocate slower drying with sufficient exposure to the air to prevent fermentation. Such hay will be found to be less tough, of better flavor, and more nutritious. Haying is now done mostly with the aid of machines, the four principal ones being the mower, the tedder, the rake or the loader, and the horse fork. The tedder is not so much used as formerly, at least in some sections.

**102. Alfalfa.**—This forage crop has increased very rapidly in popularity during the past ten years. It is a deep-feeding plant. The roots often go into the soil ten or twenty feet, and sometimes even deeper. It will not do well where the subsoil is heavy and not well drained. Alfalfa is a good hay crop, but it may be used for pasture also. It should be cut for hay when it first begins to bloom. Care is necessary in handling it when dry that the leaves are not broken off, as they contain the most nourishment for the stock. Three to six cuttings of alfalfa may be made in a single season after the plants have become firmly established. It usually takes about three years for the plants to develop their root system fully. Then the field may be mowed for many years if a little fertilizer containing calcium, potassium, and phosphorus is added. The alfalfa will be able to supply its own nitrogen, as explained in the previous chapter.

**103. Clovers.**—In Chapter VI the clovers were considered with regard to their effect on the soil. Clovers make excellent forage for stock and are so used in all parts of the country. Clover hay requires careful drying or it will not keep well. Red clover is most commonly raised in the North. Timothy or other grass seed is usually sown with it. It is best cut before many of the blossoms turn brown, because the leaves will fall if it is too ripe. Crimson clover seems to thrive better in the South, and may be sown in the fall and used as a cover crop. If sown in the spring it will mature late in the summer. Crimson clover does not seem to do so well in the North, as the winters are too cold. White clover is used with grass seed for pastures.

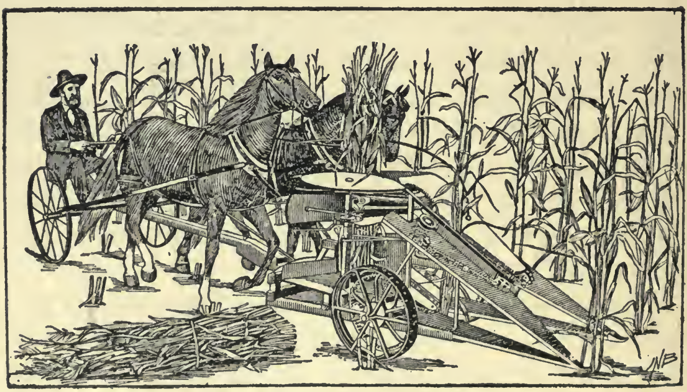
**104. Corn.**—Corn is the second crop in importance in the United States. It was found in America when the first explorers came. It was then known nowhere else, but now it is raised in all parts of the world where it will grow. It requires much sunshine and warm weather and is therefore grown in temperate and subtropical countries. It is used for feeding stock, for human food, and for making starch and whisky. Among the types of corn may be mentioned flint, dent, pop corn, and sweet corn.

Corn requires a light, rich soil and does not do well on a heavy soil. There should be much humus present. If planted on sod, the ground may be plowed in the fall and thoroughly cultivated. This is not good practice in the South, however, because of the heavy winter rains. Corn is planted in hills three to four feet apart or in drills three feet apart. The plants in drills should

be eight or ten inches apart. The seeds should not be sown until the ground is warm and danger of frost is over.

Just before the plants come up, the ground may be harrowed with a light, fine-toothed harrow to break up the crust so that the plants may more easily push through. This also kills weeds. The ground is sometimes dragged with a light harrow even after the plants are up, care being taken to hit as few plants as possible. The field should be cultivated as often as necessary in order that the weeds may not get a start, and to preserve a surface mulch. This should be done as soon as possible after each rain.

When raised in large quantities, corn is now planted and harvested by machines. Some seeders are so ar-

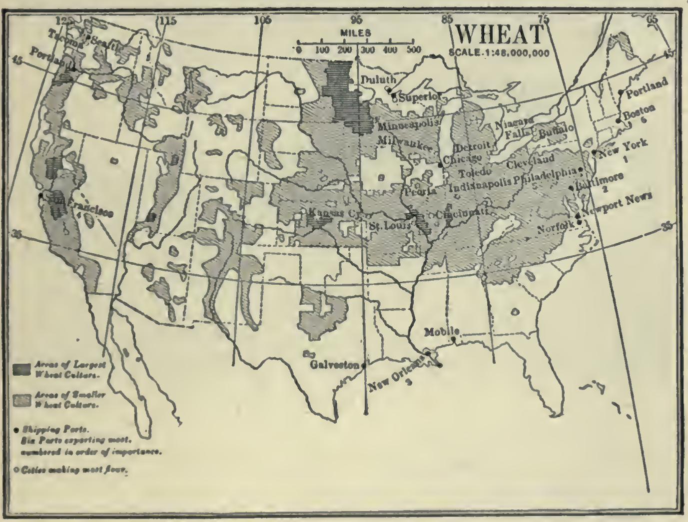


VERTICAL CORN HARVESTER.

ranged that they plant the corn in hills equally spaced so that the field may be cultivated both ways. More

often the corn is drilled in. The harvesters cut the corn and bind it in bundles to be picked up and stacked by hand.

In many places the corn, stalks and all, is cut up and packed in silos as green fodder to be fed to the cattle through the winter. Sometimes the ears are picked off and only the stalks cut up for the silo. A silo is a large, air-tight pit or room where the material keeps moist and fresh. Corn, or other forage crops, put up in this way is called ensilage.

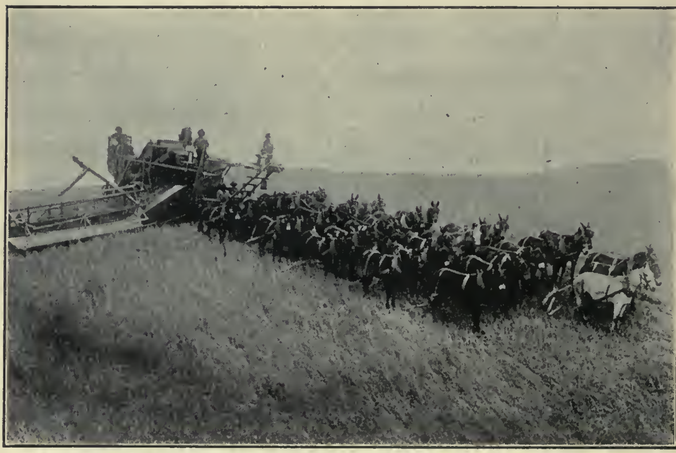



MAP SHOWING PRODUCTION OF WHEAT IN THE UNITED STATES.

**105. Wheat and Other Grains.**—Wheat ranks next to corn in importance. Oats and barley, though following cotton in the value of the crop, may properly be discussed with wheat. There are several varieties of wheat,

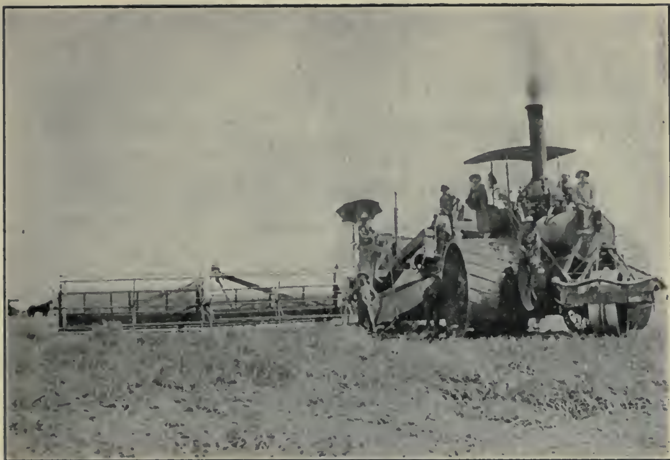
as spring wheat and winter wheat, white, red, hard, and soft varieties, and bearded and bald varieties. The territory for raising wheat in the United States is shown on the accompanying map.

The ground for wheat, oats, and barley should be rich and mellow, but it need not be as light as for corn. Experiment and farmers' experience show that the yield of wheat is determined chiefly by the supply of nitrogen



Wheat Harvesting Machine. (Horse power.)

in the soil or in the fertilizer used. With barley nitrogen is also essential, but phosphoric acid has an equally marked effect. Wheat has a long growing season and therefore has an opportunity to get plenty of food. These three grains should all be planted near the surface of the ground. It is their habit to "stool" or send out a bunch of roots from a joint just below the surface, and later the part of the root below that point dies. If the



A 50-HORSE-POWER COMBINED STEEL HARVESTING MACHINE AND THRESHER. (Steam power.) Front view, showing the wheat being cut.

COMBINED HARVESTER MACHINE. Side view. The machine cuts the wheat, threshes it, and delivers it ready sacked in one continuous operation.

plant must force its way up very far before it stools, it is weakened; hence the necessity for planting near the surface.

Certain experiments have shown that it pays to harrow these grains when a few inches high, for while a few plants may be destroyed, the vigor of the others is increased. Weeds are thus kept down and moisture is held in the soil.

Export Wheat in Bags. Two hundred and fifty thousand bushels of wheat at Portland, Ore., in bags ready for shipment. Wheat is exported in bulk (loose) from Atlantic, and in bags from Pacific, ports.

As oats are likely to shell, they are generally cut before they are ripe and while the straw is green. Barley that is to be used in making beer must be fully ripe before it is cut. Wheat is generally allowed to ripen before cutting. The quality is better, however, if it is cut a little before it is ripe, when the thumb nail will indent but not crush the kernel.

There is always a market for wheat and it brings a good price. Oats and barley mature earlier than wheat and give back to the farmer the money invested in a shorter time.

**106. Field Peas.**—Many farmers are finding it to their advantage to raise crops of field peas. The production is large and the crop a most valuable one. It is fed either as a green crop or cured. As the peas need a support they are generally sown with some other crop, as oats. Peas do best upon a heavy moist loam and grow best in cool climates. They are planted in drills or broadcast and should be covered deeply, with a disk harrow. Several days later the oats are sown and covered with a fine-toothed drag, after which the ground may be rolled.

**107. Potatoes.**—The United States produces annually two hundred million bushels of potatoes. The yield may possibly be doubled before long, because of the increasing use of denatured alcohol, in the manufacture of which potatoes, as well as corn, are largely used.

Potatoes are raised from seed pieces or cuttings, that is, sections of a potato containing one or more eyes. The eyes are really buds, for the potato tuber, as it is called, is really an enlarged and specially developed stem, and not a real root.

The soil for potatoes should be rich and deep and the seed pieces should be planted deep. Above the seed there must be room for the growth of the new potatoes. Cultivation of the soil should be kept up until just before the plants cover the ground.

Potatoes are subject to scab (Sec. 72). This disease may be prevented by soaking in formalin mixtures the potatoes to be used as seed. Often the plants must be sprayed to prevent blight. Experiments on farms in Wisconsin in 1905 showed that the average cost of spray-

ing five times was $3.65 per acre, and the gain in value of the crop of potatoes varied from $19 to $38 per acre. These experiments were tried on six- to ten-acre areas.


POTATO SPRAYING EXPERIMENTS.
The gain due to spraying was 233 bushels per acre.
From Harwood's "The New Earth," by courtesy of The Macmillan Company.

The sprayed plots were each one acre and the "check" plots, not sprayed, were one half acre. This made the experiment extensive enough to be convincing.

Raise potatoes and spray some with Bordeaux mixture and leave some unsprayed. Notice the difference in results.

**108. Root Crops.**—Under the head of root crops—that is, plants whose roots are used for food—we may mention beets, sugar beets, carrots, and turnips. Much

attention is now being given to raising sugar beets. In the neighborhood of a beet-sugar factory they are especially profitable, because they are raised on contract, and the farmer knows beforehand the price at which he is to sell his crop. For this crop the ground should be plowed and manured in the fall, and then plowed again and harrowed in the spring. The soil must be deep, so that the plants will not be pushed up out of the ground as the roots grow, for the part above ground is waste. Commercial fertilizers containing much potash are often used. They should be put on in the fall so that they may be washed into the lower part of the soil. The seed is sown by machine in rows eighteen inches apart. When the plants are up so that they show in the row, they are thinned with a hoe. A few days later they are thinned by hand so that the plants will be ten inches apart.

Carrots are grown largely for feeding to stock, although young carrots are much used for human food, especially in cities. They require an exceedingly mellow soil, sandy preferred, and must be kept free from weeds. They should be planted rather early for the early crop and as late as the middle of June for a late crop, after the weeds have been killed by harrowing (Sec. 25).

Turnips are often sown broadcast as a "catch" crop —one sown between the periods of other crops—after early peas or potatoes. They are used somewhat as a table food, but mostly for stock.

**109. Cotton.**—Cotton is of so much importance in the Southern States that it has won the name King Cotton. Although a tropical plant, it thrives in the temperate

zone. For its best production it should have a "climate with six months' freedom from frost, a moderate well-distributed rainfall during the plant's growing season, and abundant sunshine and little rain during its maturing period." The value of the cotton plant resides in the long fiber attached to the seeds.

There are two varieties of the plant important in the United States—the short-stapled upland variety, commonly grown in the Southern States, and the long-stapled variety called Sea-Island cotton, grown on islands off the coast and in some parts of Georgia, South Carolina, and Florida. The long-stapled variety commands the better price. Some progress has been made by seed selection, cultivation, and hybridizing in improving the quality of the short-stapled variety. The cotton plant requires a rich loam soil well cultivated and deep, as the plant has a long tap root. As it makes very heavy drains on the soil, wherever it is raised there should be kept enough stock to consume the seeds and return the fertilizer to the land. Peas, beans, clover,

COTTON PLANT. *a*, flowering branch; *b*, fruit (boll) bursting; *c*, seed with fibers (lint). After *Wossidlo.*

and peanuts may be raised as a further benefit to the land as well as for additional fodder.

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COTTON FIELD.

**110. Sugar Cane.**—Sugar cane was originally a wild plant that had two to four per cent of sugar, but it has been improved until now there is as high as sixteen per cent. In Louisiana the average amount of sugar in the plant is about eleven per cent.

Sugar cane is raised from cuttings of the old stalks. Trenches are plowed and the stalks are covered. The land must be tilled and kept free from weeds. The land is planted every second or third year in the United States, but in tropical countries plants will spring up from the stubble for ten years.

111. **Rice.**—Rice is one of the most important foods of the human race. Although several states are adapted to its culture, we import more into the United States than we raise. There are many varieties of rice, but for practical purposes we may consider two kinds, upland and lowland. Upland rice is treated about the same as the other small grains, but lowland rice is raised only on land that can be flooded. Most of the rice grown in America is produced on the rich lowlands along streams, marshes, or level lands capable of irrigation. Not enough attention is given to the raising of rice in this country.

112. **Tobacco.**—In some parts of the United States the raising of tobacco is an important industry. The United States raises more than twice as much tobacco as any other country in the world. There are several important varieties, which vary considerably in their cultural requirements.

Tobacco plants require a light, rich soil for their growth. In the preparation of the soil it is customary to plow the land in the autumn to secure the benefit of winter weathering. In the spring the fertilizers are added and the land is again plowed, harrowed, and laid out in ridges about three to four feet apart. The seed is sown early in a specially prepared bed, which is usually in a sheltered place where the young plants can be pro-

tected. Sometimes the entire bed is covered with glass or cheesecloth. When the young plants are three or four inches high they are transplanted to the ridges in the field, and set twelve to twenty-four inches apart on the ridges, depending on the variety. This was formerly done entirely by hand, but now transplanting machines are generally used. A machine drawn by horses makes the hole in the ground and sets the plant, which is put in position by a man on the machine, and then presses the earth around the roots. By the use of such a machine two men can plant three to six acres per day.

TOBACCO PLANT.

During the growth of the plants the soil is constantly kept in good tilth by the use of cultivators and hoes. When the flower buds appear the stem is broken off about three feet from the ground, to keep all the strength of the plants for the growth of the leaves. This process is called "topping." Following this the young shoots, called suckers, which grow in the axils of the leaves, are also broken off.

As the leaves ripen there are two methods of harvesting. In the one case they are broken from the plant and hung in a shed to cure. In the other method the entire

plant is cut down and hung in a shed when some of the leaves are just ripe and others are still green. By this method the leaves do not all cure alike, as they do when

Tobacco Field.

all are allowed to ripen on the plant before they are gathered, but it involves less work and is in rather general use.

The separate leaves, or the stalk and leaves, which were hung in the sheds are allowed to dry and at the same time undergo a change called "curing." The value of the leaf depends to a considerable extent on the satisfactory completion of this "curing." The sheds are constructed so as to regulate the supply of air currents, moisture, and heat. When the leaves are cured they are taken down and if still on the stalks, are stripped off and

placed in bundles to undergo a further change known as "fermentation." The aroma from the cigar depends to a large extent on this "fermentation."

The tobacco is now ready to be manufactured into cigars, or smoking or chewing tobacco. Most farmers sell their tobacco after it has been cured in the sheds and before the process of fermentation has been accomplished. The latter process is then completed by the tobacco buyers, who have special facilities for regulating the process which the farmer does not possess.

## SUMMARY

Forage crops, such as grasses, clovers, and alfalfa, are important farm crops as they are the principal feed for stock.

Corn is a very valuable crop both for human and for animal food.

Wheat is a slow maturing crop, while oats and especially barley return the money invested in a short time.

Tobacco needs an especially rich soil and requires great care in its raising and curing.

Most farm crops, except hay and small grain crops, require cultivation, which keeps the soil in good condition and free from weeds.

## QUESTIONS AND PROBLEMS

1. Is it good farming to pick the ears of corn and leave the stalks to be plowed in? Why?

2. Would you burn the straw stack after the grain is threshed? Why?

3. What would you do with the straw?

4. It cost $113 to spray 30 acres of potatoes five times. The average yield of sprayed potatoes was 240 bushels to the acre. The average yield of unsprayed acres was 150 bushels. At 40 cents per bushel, what was the gain for the thirty acres?

# CHAPTER XIV

## THE ORCHARD

**113. Apples.**—One of the most important crops that the farmer can raise is apples. Hardly any other fruit is so widely enjoyed or so useful. An apple has two thirds as much nutriment as a potato of the same weight. For eating out of hand it is always in demand. When cooked in the form of sauce, pies, dumplings, baked or any other form, it is of superior excellence. The juice, when sweet, furnishes a fine beverage, and when sour and fermented, produces a vinegar that has no rival. By a proper selection of varieties, a supply of apples may be had the year round.

The apple tree is started from the seed. As it will not come "true" (Sec. 94), at the end of the first or second season a scion of the desired variety is grafted on the seedling roots (Sec. 94). For this purpose the seedling is taken up, and the scions and seedling should be kept in a cellar in moist sand. In the spring it is planted again, and after one or two seasons of growth it is ready for the market.

A clay loam soil (Sec. 8) seems best adapted to raising apple trees. Generally, the land should have an eastern or northeastern slope, to lessen the danger from

sun scald in long summers. The soil should be in good condition, well tilled, and with a natural drainage, because apple trees will not endure a water-logged soil. The trees should be set twenty-five to forty feet apart each way.

In general, the land between the trees should not have crops grown on it, although this will vary with the particular circumstances sometimes. Clover may be grown and left on the ground as a mulch. This will

Picking and Packing Apples.

provide nitrogen (Sec. 41) and protect the ground from the heat of summer and the cold of winter. If necessary, fertilizers should be used, consisting of barnyard manure or wood ashes. Four hundred to six hundred pounds to the acre of wood ashes is a suitable application.

Anyone intending to raise apples should first find out from his neighbors what varieties have proved successful in his locality. It is not well to invest too heavily in untried varieties. The safest varieties, where they will grow, are the standards, such as the Baldwin, Greening, Winesap, Oldenburg, Red Astrachan, and Northern Spy.

Apple trees should be pruned to produce large fruit and to facilitate picking, among other things. The trees must be sprayed at the proper time to prevent the ravages of insects and diseases. It is a waste of time and money to raise inferior apples.

The picking must be done by hand, and care must be taken not to loosen the stem from the apple. The apples should be carefully packed in barrels or crates, and should be slightly shaken together and compacted, to keep them from rattling around and bruising each other.

**114. Pears.**—Pears are a much esteemed fruit, and great quantities are sold in the markets for immediate consumption and for preserving.

Pears are propagated by budding or grafting (Chapter XI) upon the seedlings. A good soil is required. The trees may be set closer than apple trees. It is best in setting out a pear orchard to use more than one kind, as the trees may not bear well unless their blossoms are fertilized by pollen from a different variety (Sec. 81). Pear trees do not require so much pruning as apple trees, their habit being to branch very much less. What was said about care in picking and handling apples applies with even more force to pears. They are often wrapped separately in paper and packed in crates only one or two layers deep.

Pear trees are subject to many ills, among them blight and tree girdlers. The blight is caused by a fungus which causes the ends of the twigs to die. The pear-tree girdler lays her eggs in the twigs and then girdles the twig, with the result that the young have dead wood in which to develop. For both of these, the dead twigs should be removed and burned. In case of blight, the branches should be cut off a foot below the affected part.

**115. Peaches.**—The peach is another favorite fruit for eating either raw or cooked. It stands among the first for canning purposes. New Jersey, Michigan, Georgia, and California are great peach-growing states, but in many other states the fruit grows well.

Peaches are propagated by budding, which is done in the fall. The bud should be set on the north side, so that it will not get too much sunlight. As soon as the bud shows life the next spring, the stock is cut off a few inches above it. All other buds should then be rubbed off and not allowed to grow. As soon as the bud has made a good growth, the old part of the tree should be cut off close above it so that the cut may heal over before winter. In the following February the new shoot must be pruned back. Pruning must be done every year in order that the tree may have symmetrical development and the proper number of branches be allowed to grow.

The first year the tree bears it should be allowed to bear not more than three or four peaches, and the next year not more than a peck. A tree properly treated will bear five to ten bushels for twenty years.

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**116. Cherries and Grapes.**—Cherries and grapes are raised with as little trouble as any fruits and are always desirable. Grapes should be sprayed with Bordeaux mixture as the buds break, to prevent rot and mildew. Some persons spray cherries with kerosene emulsion just as the blossoms fall as a safeguard against the moth that would otherwise lay its eggs in the ovary of the cherry blossom. Cherries and grapes always find a ready market, and if they are of good varieties and have been carefully picked, they bring a good price.

**117. Marketing Fruit.**—A fruit well raised is half sold; but if fruit is raised for the market, as much judgment may be needed in marketing as in raising. There will always be more than one grade of fruit, and each grade should be sold for just what it really is. There is generally a demand for second-grade fruit, but not at first-grade prices.

Fall fruits and those which perish easily should be disposed of as soon as possible. It is better to sell for a small profit than to risk losing the whole. The fruit raiser should know the condition of crops in all parts of the country, so that he may be able to judge whether it is best to hold his crop for a higher price. He must also decide whether it is better to sell at once at a small price than to get a large price later, after part of his fruit has spoiled and he has had the expense of sorting it.

**118. Transplanting and Pruning.**—In transplanting trees, choose the time when the leaves are off and the ground is moist. Dig the tree carefully so as not to cut off many of the small terminal rootlets, or to let the roots get dry by exposure to the air. In any soil

1. Dig the hole twice as large as seems necessary and fill in the bottom with fine rich soil.

2. Pack the soil firmly about the roots, taking care to spread them.

3. After the roots are carefully covered press the earth down as the hole is filled.

4. After the tree is planted mulch it with loose earth so that the moisture may soak in.

dig the hole twice as large as seems necessary, and fill the bottom with fine rich soil. Pack the soil firmly about the roots, taking care to spread them and not to double them back. Be sure that the roots are not only set in good fine soil, but that there is plenty of loose soil for them to grow into. One person should hold the tree and another should get down and with his hands work the soil all about the roots.

After the tree is placed and the soil replaced, mulch it with six inches of leaves or loose manure. Do not have sod anywhere above the roots of a newly set tree. Drive in two stout stakes and fasten the young tree, being careful not to compress or injure the bark. Finally, prune back the top as much as the roots were pruned in taking up the tree. Remember that the roots must never become dry while being transplanted. In some localities it may be necessary to keep the tree watered the first season or two, but in most places this will not be necessary if the surface soil about the trunk is kept stirred.

Pruning is done to change the vigor of the plant, to remove dead wood, to produce better fruit or flowers, to open the plant to light and air, to keep the plant within manageable shape and size to facilitate spraying, gathering fruit, and cultivating, or to train to some desired form. When young trees are set it is generally best to prune some branches to allow for the roots destroyed in transplanting. The size and quality of fruit are made better by judicious pruning. Excessive pruning causes overgrowth of wood. Grapes are produced on the season's growth of shoots from the previous season's

growth, and so it is desirable to start each season with wood only a year old. Blackberries and raspberries grow on the preceding year's canes, so old canes which have borne once should be cut out. The growing canes should be cut off or headed-in when the plants are two to three feet high.

In regard to the time of year for pruning, opinions differ. It is generally agreed, however, that grapevines should be pruned in the fall or winter, and trees before growth begins in the spring—February, March, and early April in the northern latitudes. Dead wood may be removed at any time.

Good authorities differ in regard to dressings for wounds. Professor Bailey, of Cornell University, concludes as the result of many experiments that there is nothing better than lead paint, but that the nature of the wound and its position on the tree have more influence on the healing than either the season of the year when the wound is made or the kind of dressing used. All authorities agree that the wound should be smooth and the heel short, so that the bark may grow over and cover the wound. Careful pruners cut off large branches twice. The first time they saw about halfway through on the under side and then saw down on the upper side a short distance farther out. This prevents the limb splitting as it falls off. The short stub is then sawed off close to the limb or trunk.

Note various trees as to methods of pruning—long stubs and short, and relative healing.—Choose two trees of a certain fruit side by side. Spray one, and compare results at harvest.—Study pruning methods in the best orchard in your vicinity.

## SUMMARY

The apple is one of the most universally desired fruits, and by a careful choice of varieties a supply may be had the year round.—The pear is easily raised and is excellent for canning purposes.—The peach is one of the most delicious of fruits, both for eating fresh and for preserving. It may be grown where the winters are not too severe.—Cherries are always salable and require little care or expense.—To get good fruit, the farmer must have good stock, properly budded or grafted, and must give attention to the condition of the soil, pruning, and protection from insect enemies and plant diseases.

A small extra expense in properly picking and preparing fruit for the market will often bring large returns.—The fruit grower must keep informed of the general condition of crops so as to determine when to sell and what price he can get.

## QUESTIONS AND PROBLEMS

1. Why is the apple king of fruits?

2. Why is it generally advisable not to raise crops between the rows in an orchard?

3. Would you let hogs into an old apple orchard? Why?

4. How many trees may be set in a one-acre lot, 16 rods long, if the trees are 2 rods apart, no tree nearer than 1 rod to the sides of the field, and the end trees set on the line?

5. If the crop is worth $10 per tree, what would be the value of the yield per acre?

6. A man had 200 barrels of apples that he could have sold at $2 per barrel, October 1st. He kept them until April and hired a man for $10 to help him sort and repack the two thirds which had not decayed. Then he sold them for $3 per barrel. If interest on his money was worth 5 per cent, how much did he lose?

7. How much time, at $2 a day, will 5 barrels of apples pay for, at $3 a barrel?

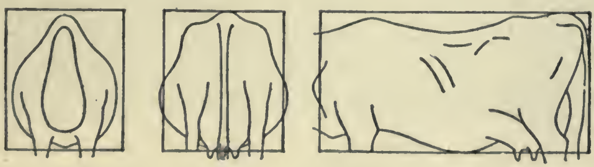
8. How many grapes at 25 cents a basket will it take to pay for a half hour's care four times in a season, allowing 20 cents an hour for labor?

# CHAPTER XV

## CATTLE

**119. The Usefulness of the Cow.**—Perhaps the most important animal kept on the farm is the cow. Among its more important products are milk, butter, cheese, meat, leather, manure. The cow is useful to the farmer chiefly for dairy purposes and for beef. Some breeds of cattle combine, in a measure, the qualities of both dairy and beef types.

**120. The Dairy Cow.**—The dairy type is characterized by leanness and angularity. It has large abdominal capacity, deep chest, a small head, and large udder. The neck is long, thin, and muscular. The back is



*a* *b* *c*

DIAGRAM SHOWING DAIRY TYPE OF COW.
*a*, front view; *b*, rear view; *c*, side view.

strong, rather long, with prominent backbone. The hips are wide apart and prominent. The milk veins are prominent and branching. Looked at from the side,

front, and above, it presents the form of a wedge. The four principal dairy breeds are the Holstein-Friesian, Guernsey, Jersey, and Ayrshire.

The Holstein, while a good milker, is used also for beef. It is the largest of the dairy breeds, although the

HOLSTEIN, COLANTHA FOURTH'S "JOHANNA," CHAMPION DAIRY COW OF THE WORLD. Record for one year: milk, 27,432.5 lbs.; average test, 3.64%; butter fat, 998.26 lbs. Owned by W. J. Gillett, Wisconsin.

size varies somewhat according to the feed and care the animal receives before reaching maturity. The colors are black and white. It has been bred in the Netherlands for two thousand years. There it is kept in winter in the common shelter, separated from the family by a thin partition only. The abundance of milk, and the large size of the animal, are attributed to the great care exercised by its breeders for so many generations and the rich pastures which it always enjoyed. The cows

give a large quantity of milk, but the percentage of butter fat may be small. In spite of this, however, the Holstein has now (January, 1910) the champion dairy cow of the world, Colantha Fourth's "Johanna" having produced in one year 27,432.5 pounds of milk averaging 3.64 per cent fat, and 998.26 pounds of butter fat.

The Guernsey is a rather large animal of a quiet disposition, though generally not so large as the Holstein. The color is generally light brown, with white patches on the body and legs. The ears are yellow on the inside.

GUERNSEY BULL, "CASTERILIUS," No. 10980.
Owned by Ralph Tratt, Whitewater, Wisconsin.

The average weight for mature cows is 1,050 pounds, and for bulls about 1,500 pounds. The milk of the Guernsey often tests five per cent or more of butter fat. The milk, cream, and butter from this breed are generally a deeper yellow than that of the other breeds. The

Guernsey cow, "Yeksa Sunbeam," has a record for 1908 of 14,920.8 pounds of milk testing 5.74 per cent fat, and 857.15 pounds of fat. "Dolly Dimple," 3½ years old, is the champion Guernsey heifer (1910). She has a

"Yeksa Sunbeam," Guernsey Cow. Record for one year: milk, 14,920.8 lbs.; average test, 5.74%; fat, 857.15 lbs. Owned by Rietbrook Estate, Wisconsin.

record of 906.89 pounds of butter fat. The Guernsey has the record for producing more pounds of butter fat in proportion to cost of keeping than any other breed.

The Jersey originated on the island of Jersey, near the coast of France. It is a remarkably high-bred, fine-grained animal. The color may be any shade of brown to black, various shades of yellow fawn, and tan, or even white. Fawn and tan seem to be the favorite colors in the United States. Around the muzzle there is a characteristic ring of light-colored hair which gives the ani-

mal the appearance of having dipped her nose in meal. Mature cows should weigh 800 to 1,000 pounds and bulls 1,200 to 1,500 pounds. The milk of the Jersey is often too rich to feed undiluted to calves. The champion Jersey cow of the world (1910) is "Jacoba Irene," with a record of 924 pounds of butter fat in a year.

JERSEY COW, "LADY PANDORA," No. 173727.
Owned by F. H. Scribner & Sons, Rosendale, Wisconsin.

The Ayrshire is a native of Scotland, where it is very hardy, being accustomed to roam long distances for its feed. It is sprightly and active and well adapted for hilly pastures and hard conditions. The color is usually red and white, the two colors not being mixed, but ex-

isting in patches. The standard weight for mature cows is 1,000 pounds, while bulls should weigh 1,500 pounds or more. The breed is noted for the large quantity of milk yielded in proportion to the size of the animal and to the quantity of food consumed. The milk is said to be more easily digested than that of some other breeds.

"Rena Ross," Champion Ayrshire Cow of the World. Record for one year: milk, 15,072 lbs.; average test, 4.26%; fat, 643.2 lbs. Owned by John Valentine, Pennsylvania.

The champion Ayrshire cow at the present time is "Rena Ross," with a record of 15,072 pounds of milk testing 4.26 per cent, and 643.2 pounds of butter fat.

**121. Beef Breeds.**—Among the most common special beef breeds in America are the Hereford, Galloway, Aberdeen-Angus, Shorthorn, Polled Durham, Polled

Hereford, and Sussex. The general form of the beef animal is broad, straight, deep, and compact. Viewed

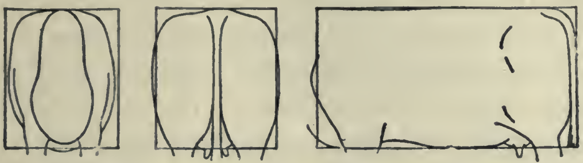


DIAGRAM SHOWING BEEF TYPE OF COW.

from almost any point the body should show a rectangular or parallelogram shape. The legs are short, the loins, back, and chest thickly covered with flesh. The

HEREFORD COW.

hips are smooth and wide apart. The angularity, characteristic of the dairy type, does not appear.

12

The Hereford, first brought to this country in 1817, has been imported in great numbers since 1879. This breed is red, with a white face and a white line extending back from the head to a greater or less distance. The Galloway, first imported in 1853, is used on the Western ranches because of its hardiness. The hair is long, fine, shaggy, thick, and black, sometimes tinged with brown, and the animals are without horns. In the Middle West the Aberdeen-Angus is kept in greater numbers than the Galloway. It is a larger animal than the latter; the hair is smooth and black, and it is hornless. It was first imported in 1878. The Shorthorn is the most numerous beef breed in America. It has been bred for both beef and milk, so that we find distinct meat and dairy types. When the time of usefulness for milk is gone, it is easy to make good beef cattle of them. In color, the Shorthorn is red and white, or any mixture of these. Unlike the strict dairy cow, the food of the Shorthorn goes rather to flesh than to milk. This breed was first imported in 1783.

The Polled Durham resembles the Shorthorn, except that the former has no horns. This breed has the distinction of being the only breed of cattle originated in the United States. The Polled Hereford is merely a hornless type of the Hereford. The Sussex, imported from the county of that name in England, has never attained great popularity in America.

**122. Advantages in Raising Cattle.**—You can easily think of many advantages in raising cattle. A ton of hay or grain is worth more made into beef or milk or butter than it is in its raw condition. Cattle furnish an

income all the year. In no other way can the fertility of the land be maintained so surely and easily as by the use of barnyard manure (Sec. 35). The animal furnishes a variety of profitable farm products. The keeping of livestock greatly affects the whole plan of farm management.

**123. The Importance of Good Cattle.**—A good animal is one that produces the most value from a given amount of food consumed. Many farmers do not realize the importance of this. A little figuring will show that a good cow will soon pay for the difference between her cost and that of a poor individual. Since it costs little more to keep a cow that will furnish a pound of butter a day than one that furnishes one fourth that amount, it is best for the farmer to consider how he may have good cattle.

If the student lives on a farm, he should find the amount of feed consumed, the amount of milk given, and the percentage of butter fat for each cow kept on his farm.

**124. How to Improve the Herd.**—The farmer who wishes to make as much as possible from his cattle will constantly improve his herd. Unless he is making a business of selling pure-bred cattle it is not necessary that he have pure-bred animals. He may keep up his herd by buying good cattle and taking care of them, feeding them properly, and seeing that their surroundings are healthful (see Chapter XX). Or he may improve the herd by breeding from pure-blood or high-grade males. By selling off the lower grade and keeping only the best the quality can be raised. Even with

cattle of the same grade there may be individual differences and those that excel in the points desired should be retained and others raised from them. Many of our best herds are thus produced by "grading up." Starting with a pure-bred male, the third generation will be seven eighths pure and the fifth generation nearly as good as pure.

1. After studying this chapter, the student should take occasion to observe different breeds of cattle and note their differences. Special visits should be made to farms where other breeds are kept.

2. The amount of feed and product of each cow of the home herd should be determined and the unprofitable cows singled out.

## SUMMARY

Farm cattle are of two types—dairy breeds and beef breeds—distinct in appearance and in the purposes for which they are raised. Cattle are necessary on a farm in order to maintain the fertility of the soil, among other things.

The animal eats the product of the soil and turns it into profit, furnishing a variety of valuable products.—The poor animal costs as much to keep as the superior one—The farmer should know the producing value of individual cattle, and should use this knowledge to improve his herd by breeding.

## QUESTIONS AND PROBLEMS

1. Mention some characteristics of the dairy cow.

2. Why should a dairy cow have a large stomach?

3. What are the advantages of hornless cattle? Does it pay to dehorn cattle?

4. Why is it better to sell beef than corn?

5. If in a year a cow eats three tons of hay worth $10 per

ton, half a ton of mixed feed worth $20 per ton, and $6 worth of pasture, what does it cost to feed her?

6. If a poor cow gives 15 pounds of milk daily for 300 days in the year, what is the return at $1.25 per hundred pounds?

7. A herd of 15 Guernseys gave an average of 6,626 pounds of milk per year. What was the return per cow if each ate the amount stated in the fifth problem?

8. If the milk was used for butter and produced 355 pounds per cow, what was it worth at 25 cents a pound for the 15 cows?

9. If each cow produced one calf worth $5 and $10 worth of manure, how much did the farmer get for his work?

10. If six pounds of fat will make seven pounds of butter, how much would the butter made from the yearly yield of "Rena Ross" be worth at 25 cents per pound?

11. If the feed for the year cost $60, what was the return for care and profits?

12. Estimating the weight of milk as a pound to a pint, what would the milk of "Rena Ross" bring at five cents a pound?

13. Calculate the weight of butter, value, and value of the milk for each of the other cows whose pictures are given.

# CHAPTER XVI

## MILK AND ITS PRODUCTS

**125. The Composition of Milk.**—Milk consists of water in which certain solids are dissolved and others are suspended. About eighty-seven per cent of milk is water. In this water are floating minute globules of fat, comprising about four per cent of the milk. Casein, which is proteid (Sec. 52), forms about two and one half per cent of milk. About five per cent is sugar. A little more than half of one per cent each of albumen and ash, which are mineral salts, makes up the remainder. The average composition of milk is shown by the accompanying diagram.

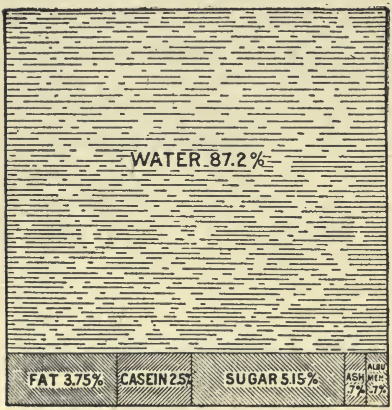
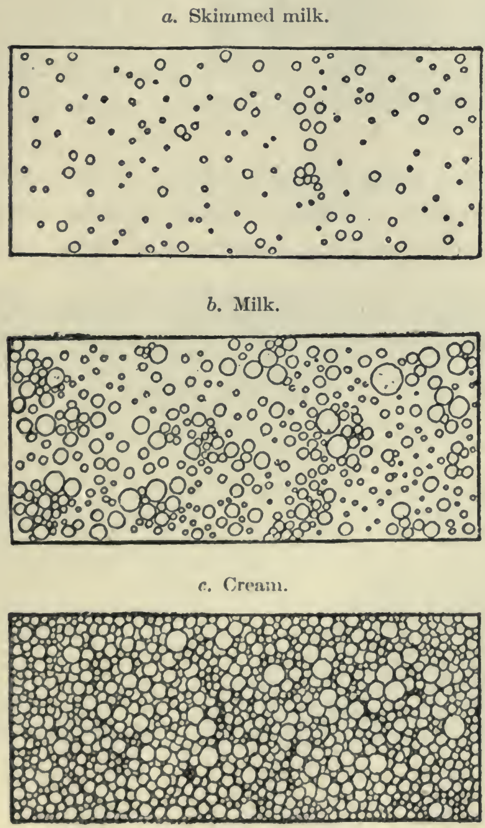



Diagram Showing Composition of Milk.
(S. M. Babcock, Wis. Bul. No. 61.)

The fat globules average one ten-thousandth of an inch in diameter, which means that forty of them placed

side by side would extend a distance equal to the thickness of this paper. In the milk of Jersey and Guernsey cows these globules are larger than in the milk of some other breeds, and so the cream (which




Different Grades of Milk. (Magnified 300 times.)

From *Farmers' Bulletin* No. 42, Wisconsin Agricultural Experiment Station.

contains the fat) rises more quickly on Jersey or Guernsey milk. The fat globules in the milk of Ayrshires are small.

The sugar of milk may be obtained by evaporating whey after the other parts of the milk have been removed in the making of cheese. Milk sugar, or lactose, as it is called, is generally seen in the form of a white powder, which is used by druggists and others who prepare medicines. It is not so sweet as ordinary sugar.

Albumen is the substance that rises as a thin, tough skin when milk is scalded. It is often seen on the top of a cup of chocolate or coffee.

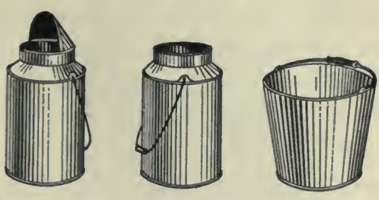
The first milk given by a cow for the young calf is called *colostrum.* It contains five or six times as much protein as does ordinary milk and is not good for ordinary purposes.

Heat some milk and note the albumen on the top.

**126. The Food Value of Milk.**—Milk is one of the most perfect foods, as is shown by its use as the entire food of babies and young animals. It contains casein and albumen to form muscle, fat and sugar to produce fat and energy, and mineral salts to produce bones.

**127. The Souring of Milk.**—The souring of milk is caused by bacteria. These minute plant growths (Sec. 32) may come from the air or from milk pails and other utensils in the dairy that are not kept absolutely clean. They act on the milk sugar, changing it to "lactic" acid, which results in curdling the milk. Milk is a

specially good home for bacteria as it contains just the food and moisture they need. When it is at the right temperature, they develop very fast.



MILK PAILS. Note which one is best protected from the dust and dirt.

To avoid souring the milk, every precaution for cleanliness must be taken. The hands and overalls of the milker should always be clean at milking-time. Milk pails, cans, and bottles, as soon as emptied, should be washed in scalding water and aired in the sun. If they can

MODEL ROOM AND APPARATUS FOR WASHING MILK BOTTLES.

be sterilized by steam, so much the better. No work that stirs up dust, such as pitching hay, should be

done in the barn just before milking. It is generally advisable to brush off or moisten the cow's sides shortly before milking. If care is taken always to have everything concerned in handling the milk clean, it will keep pure and sweet much longer than if carelessly handled.

Take two samples of milk from the same milking. Allow one sample to cool naturally, and cool the other by placing the can containing it in ice water. After a couple of hours set both samples in a cool place and note which one sours first.

**128. The Milk Tester.**—In order to know the producing value of a dairy cow, it is well to test her milk in order to see what percentage of it is cream or butter fat. This can be done by means of a Babcock milk tester. It consists of a machine having a frame made to whirl rapidly, and suitable for holding tubes, or bottles, of milk. In a test bottle is placed $17\frac{6}{10}$ cubic centimeters of milk from one of the lots of milk to be tested. Before the sample is taken, the milk should be thoroughly mixed. To this milk is added an equal amount of sulphuric acid, which dissolves all of the milk constituents except the fat. The bottle is then put into the tester and whirled at high speed for five minutes. Hot water is added to bring the contents up to the base of the neck and it is whirled again for two minutes. More hot water is then added, sufficient to float the fat up into the neck of the bottle, and another whirl of a minute is given. The percentage of fat is then clearly shown on the graduated neck of the bottle.

**129. The Separator.**—When a large amount of milk is handled, the cream is generally separated from the rest


Babcock Test Outfit. 1, spring balance for weighing milk; 2, milk pail; 3, galvanized-iron box for keeping samples of milk; 4, sulphuric acid; 5, Babcock hand tester; 6, composite sample jar; 7, beaker for adding acid; 8, Babcock test bottles; 9, acid measure; 10, 25-c.c. pipette; 11, 17.6-c.c. pipette; 12, clinical thermometer; 13, hydrometer for determining strength of sulphuric acid; 14, note-book.

of the milk by means of a machine called a separator. This machine may be run by steam or by hand. A good separator, properly run, will take out at least ninety-eight per cent of the cream present, while skimming by hand by the simple gravity process often leaves twenty or thirty per cent of the cream. In the separator the unskimmed milk is made to revolve at an exceedingly high rate of speed. The milk, being heavier, is thrown to the outside of the revolving vessel, while the cream is forced inward. By means of tubes placed at the right points, the milk and the cream are drawn off separately.

130. **Cream.**—That part of the milk into which most of the butter fat finally gathers is called *cream*. It may contain fifteen to sixty per cent fat. The separation of the fat from the milk is brought about by gravity acting on the standing milk. Cream is lighter than the rest of the milk, and so the latter sinks to the bottom of the pan and the cream is pushed up. We say "the cream rises," but in reality it is pushed up.

Cream is more or less yellow in color, the particular shade depending on the breed and individual peculiarities of the cow, and the kind of food eaten. Green grass produces a more yellow cream than does dry hay.

The amount of cream in a given quantity of milk depends on the cow, and is quite independent of the feed. More feed ordinarily produces more milk and thus a larger amount of cream, but not a larger proportion as related to the whole amount of milk. One writer has said: "The richness of a cow's milk is as much a characteristic of the cow as the color of her hair, and feeding has as little to do with it."

**131. Skimmed Milk.**—The skimmed milk that is left after the cream is removed is still a good food, especially for young animals. The fat is gone, to be sure; but all the other constituents remain and a little meal will furnish an equivalent amount of nourishment. The meal costs only a fraction of what the butter fat is worth, so that it is much more profitable not to use the unskimmed milk as feed for animals. Skimmed milk contains more protein than an equal weight of potato, and nearly one fourth as much carbohydrate (Sec. 56).

**132. Butter.**—When cream has been tumbled about for a half hour or more in a churn, the particles of fat

*a* *b* *c*

A Modern Creamery. Showing *a*, pasteurizer with a capacity of 2,500 pounds per hour; *b*, vat in which cream is ripened 12 to 20 hours after being pasteurized; *c*, 1,000-pound churn.

Courtesy of the Union Produce Company, Whitewater, Wis.

unite more closely into small grains, separate from the water and other parts of the milk, and become what we call butter. This product still contains about one per cent of protein, and may contain more. Butter is generally made from soured cream, one or more days old, because the flavor of such butter is considered more desirable by most persons and it has better keeping qualities. The cream should be kept at a low temperature, 40° or 50° Fahrenheit, and the churning should be done at a temperature of 50° to 54° in summer and 54° to 58° or higher in winter.

Perhaps the best churns are those of the barrel type, in which the cream simply falls from one side of the churn to the other. The addition of paddles is thought to injure the grain of the butter. Most persons demand that their butter be yellow, so butter is colored during at least a part of the year. Annatto is the coloring matter most commonly used. A small quantity is added to the cream before churning. Butter generally contains about eighteen per cent water, salt, and curd.

133. **Cheese.**—The same separation of the casein that is caused by the souring of milk may be produced by adding rennet to milk. In cheese-making rennet is added to produce this curd. After it is properly formed by the help of heat, it is carefully cut into small pieces. Heat is applied for perhaps three hours longer to develop acidity, before the whey is drawn off. The curd is then handled to make it solid and to drain off surplus water. It is later run through a mill and cut into small pieces, salted, put in hoops and presses to form, and finally

cured in a cool room for several weeks before it is ready for the market.

Cheese contains casein, albumen, ash, and fat and is very nutritious. Sometimes the cream is skimmed off before the cheese is made. Such cheese is called skim-milk cheese, or skimmed cheese and in some states it must be made at least nine inches high to distinguish it from full-cream cheese. Fat is sometimes added to skim-milk cheese to take the place of the cream. It is then called filled cheese.

Get a little piece of rennet from the cheese factory. Place it in milk and observe the formation of curd.

The liquid left from cheese making is called whey. As it has lost its casein as well as the fat, it is not nearly so valuable a food for calves as is skimmed milk. For this reason it is often better for the farmer to carry the milk to a butter factory than to a cheese factory. It is better still for the farmer to separate his cream at home, for then it is separated before it becomes cold, he has less weight to haul, and he runs no danger of bringing back from the factory skimmed milk from diseased cows. We have learned that casein is a proteid that contains nitrogen (Sec. 52), and thus we see why it is better to carry back to the farm skimmed milk rather than whey.

The student should visit butter and cheese factories and see separators and the Babcock tester at work, if possible.

## SUMMARY

Milk is composed of water, fats, protein, sugar, and salts. It contains the food elements that produce muscle, bone, and

fat.—Cleanliness in every detail is necessary to prevent the souring of milk.—Fat of milk is made into butter.—Proteid of milk forms the bulk of cheese.—The by-product of butter-making is skimmed milk, which is more valuable as food than the by-product of cheese-making, which is whey.—It is usually better to sell butter than cheese upon the farm.

## QUESTIONS AND PROBLEMS

1. What is protein?

2. How does protein differ from carbohydrates?

3. Why is skimmed milk worth more than whey?

4. Why may it be better for the farmer to sell butter than cheese?

5. Why is it better to feed skimmed milk and meal to calves than to feed unskimmed milk?

6. How would you get the albumen out of milk?

7. One pound of butter fat will make $1\frac{1}{6}$ pounds of butter. Supposing that the separator takes out 96 per cent of the butter fat, how many pounds of butter can be made from 500 pounds of milk that tests 4 per cent butter fat?

8. If this milk would bring 80 cents per hundred pounds at the factory, how much more would the butter bring at 20 cents a pound?

9. How many hours extra work would the increase pay for?

10. Which weighs more, a gallon of cream or a gallon of milk? Give a reason for your answer.

11. What is the advantage of testing the milk of the separate cows of a herd?

# CHAPTER XVII

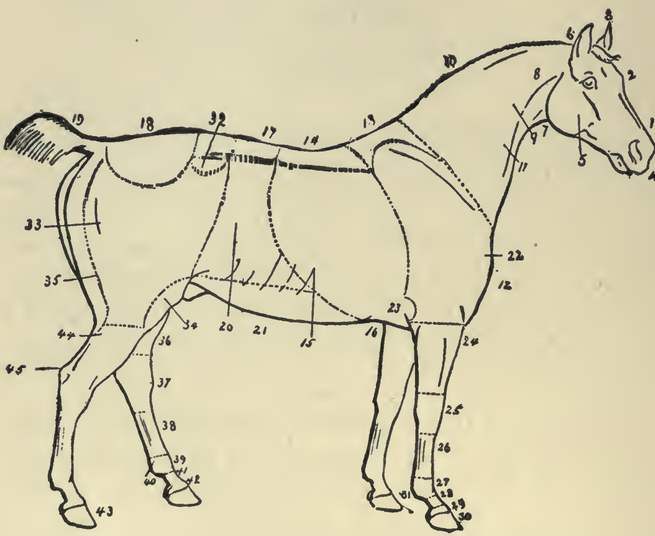
## THE HORSE

**134. Antecedents and Types.**—Geologists have determined that in prehistoric periods there were horses in the United States. The horses now used in this country, however, are descended not from these, but from imported stock, chiefly from Europe. Arabia and Eastern countries have also furnished many fine animals that have contributed to the development of the present types.

The types of horses generally recognized are classified as draft, coach, roadster, speed and saddle horses, and ponies. To these may be added a fourth type, general utility horses, or carriage and coach horses; they are heavier than the trotter and lighter than the draft horses. Although these types are very different from one another, it is believed that they have all sprung from one stock. The differences have grown out of the various conditions in which horses have lived and worked, in many different climates and through many generations. Selection and skillful breeding also have done much to change the characteristics of horses.

**135. Desirable Characteristics.**—There are certain points, well known to horsemen, which should be care-

fully observed in buying a horse. Looked at from before or behind, the legs should be straight and the feet as far apart as the width of a hoof; that is, the horse should be neither bow-legged nor the opposite. Looked at from the side, the front legs should be straight to the



The External Parts of the Horse. 1, face; 2, forehead; 3, ears; 4, muzzle; 5, cheek or jowl; 6, poll; 7, throat; 8, carotid; 9, neck; 10, crest; 11, jugular channel or furrow; 12, breast; 13, withers; 14, back; 15, ribs; 16, girth; 17, loins; 18, croup; 19, dock; 20, flank; 21, belly; 22, point of shoulder; 23, elbow; 24, forearm; 25, knee; 26, canon or shank; 27, fetlock joint; 28, pastern; 29, coronet; 30, foot; 31, ergot and fetlock; 32, haunch; 33, thigh; 34, stifle; 35, buttock; 36, leg; 37, hock; 38, canon or shank; 39, fetlock joint; 40, ergot and fetlock; 41, pastern; 42, coronet; 43, foot; 44, lower thigh; 45, point of hock.

fetlock, or pastern joint, and the hind legs should have no tendency to "cock" ankle in front, but be well set. The forehead should be broad, nostrils thin and open,

and the two halves of the lower jaw wide apart. The eye should be full and should have an intelligent, not vicious, appearance. The ears should be erect and active. In a draft horse, the chest should be broad, and in trotters it should be deep.

**136. Speed Horses.**—The Arabians, the Thoroughbred, and the families of the American Trotter are the horses noted chiefly for speed. Prominent among American Trotters are the Hambletonians, Mambrinos, and Morgans. The introduction of Arabian horses has produced great improvement in England; yet it is a fact that those imported into the United States have not been able to compete with American-bred horses. The Arabians, however, are remarkable for their beauty, intelligence, and fine points.

Thoroughbred is the name given to a distinct breed of English horses which have been bred for racing through many generations. These horses contain much Eastern blood and are noted for their speed and endurance. The colors are usually bay, chestnut, or brown, but sometimes black or gray. The Thoroughbred is used in the famous English hunting trips. The best hunting horses are a cross between the Thoroughbred and the Hackney.

The father of nearly all the American families of trotters was "Imported Messenger," brought to this country in 1788. This horse is described as having remarkable life, strength, and endurance. He was gray in color, had a large, bony head, short neck, and unusually large nostrils. "All accounts concur in representing 'Messenger' as being a horse of very superior, though not

handsome, form, and possessing extraordinary power and spirit." Hambletonian, one of the most famous of the American trotting sires, is descended on the male side from "Imported Messenger," was foaled in 1849 and kept in Orange County, N. Y., until 1876. Mambrinos are descended from "Mambrino Chief," foaled in 1844, a

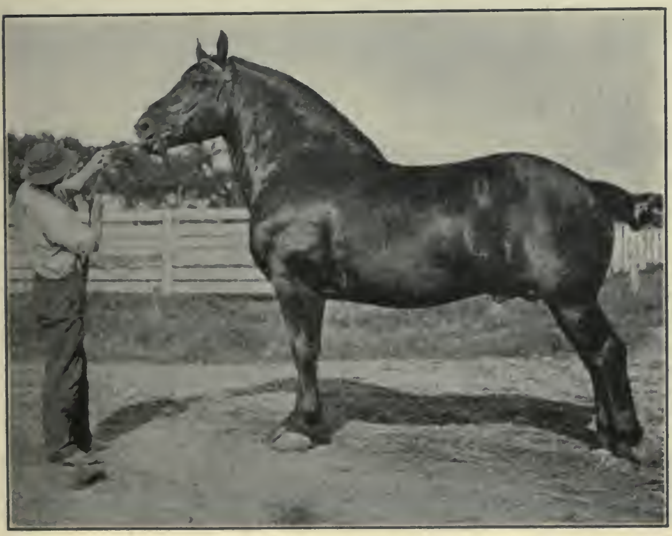
American Thoroughbred Trotter, "Major Klenert," No. 42450. Three years old; 16 hands high; record, 2.29¼. Owned by Klenert Brothers, Portage, Wis.

great-grandson of "Imported Messenger." "Mambrino Chief" lived in Kentucky and was the ancestor of many Blue Grass trotters. One of his descendants, "Minor Heir," holds the world's official record for 1908, a mile paced in 1.59½. Another famous pacer, "Dan Patch," traces his ancestry back to "Imported Messenger" forty-three times, and has a pacing record of a mile in 1.55¼.

One of the most useful of American trotters was

"Justin Morgan," the sire of all the Morgans. The Morgans are useful not only as trotters, but for family horses and for general purposes, being noted for speed, endurance, and reliability. One of these horses is said never to have lost a trip in twenty-five years of service on the Boston street-car lines. This horse, on being retired from active service, was kept by the company in comfort and luxury until he died, at more than forty years of age.

**137. Draft Horses.**—The draft horses differ from the trotters much as the beef breeds of cattle differ from the

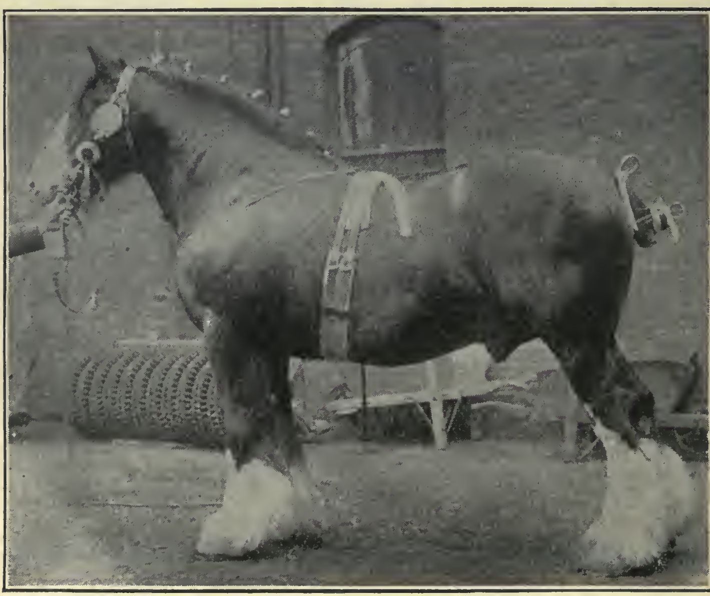


CHAMPION IMPORTED PERCHERON, "STALLION PINK."
Dunham and Flitcher, Wayne, Ill.

dairy breeds. The body is shorter, broader, and more nearly cylindrical. The legs are short and stout, the hoofs are large, and the walls are strong. They are

characterized by great weight and rather slow movements.

Among the more important draft breeds are the Percherons. These horses are often gray in color, a condition believed to be due to Arabian blood; but they are sometimes black. They are able to draw a good load at more than moderate speed, and although they are heavy horses they are by no means lacking in snap.



Champion English Shire Stallion, "Stroxton Tom." Notice the good form across the loins, wide neck well set on the shoulders, and fine forward legs.

The English Shire horse is one of the heaviest breeds. It may be almost any color, although black, bay, and

brown are the most common colors. It usually has a white spot on the forehead and may have one or more white feet. These horses can pull great loads at a slow, steady gait, but lack the life and energy of the Percherons.

The Clydesdale is another draft horse, somewhat smaller than the Shire, but much more active. It is a rapid walker and is much prized for that reason. It has a kind, quiet disposition and good courage. In its colors and markings it resembles the Shire.

Other important draft types are the Belgian and the Suffold. Neither is so popular in this country as the above breeds.

**138. Coach Horses.**—Coach horses combine the activity of the trotter with somewhat of the strength of draft horses. Many of them are required to draw heavy carriages at a good speed. They are also expected to show some style, the more the better. Among these may be mentioned the French coach horse, the German coach, and the Hackney. The Hackneys are said to give endurance to the progeny of the English Thoroughbred, with which they are crossed.

**139. Ponies.**—Shetland Ponies are the well-known sturdy little beasts that in this country are used chiefly for children's pets. They will endure almost any amount of hard usage and poor fare and will do a great amount of work for their little masters and mistresses. In England they are much used in coal mines. Their native home is the Shetland Islands, north of Scotland.

Welsh ponies are growing in popularity in America, and many are being imported and some bred here. They are also children's pets.

In the United States there are two other common breeds of ponies, the Bronco and the Northern Indian pony, which have descended from horses that escaped from the early Spanish explorers. They are the saddle horses of the Western cowboys and are good cavalry horses. They have great endurance.

Learn the different breeds of horses in your locality. Somebody knows and will gladly tell you.

**140. Use and Care of Horses.**—Although horses appear to be strong and hardy, yet they are very easily lamed or made ill. They should be fed as regularly as possible, and should not be overfed, nor should the feed be changed suddenly. The horse has a small stomach and therefore its feed should not be too bulky. Changing from old hay to new hay or grass is likely to cause indigestion, an ill which frequently becomes very serious. Overfeeding a horse that has been kept on short rations has the same effect. New oats and corn should be fed with caution. Dusty hay is to be avoided, certainly unless sprinkled. When a horse is heated, it should not be fed grain. It is safer and better to let the horse stand half an hour. A little hay may be given, but some careful owners will not give even hay to a warm horse.

Care should be exercised also not to give a heated horse too much cold water. Authorities differ somewhat in regard to watering horses before or after eating. Most persons think it is better to water the horse before eating; but if a horse is very hungry he will not drink much until after eating. Many animals, free to do as they like, eat first, then drink and lie down to digest

their food. There are reasons for believing that Nature is a fairly safe guide in these things.

Hardly any animal better repays the care given to it than the horse. A horse should be groomed each morning, to promote the health of the skin as well as to improve the appearance. In cold weather care should be exercised to prevent a horse getting chilled after being heated. It is bad practice to allow a horse to dry off in winter without a blanket, or to sleep in a wet blanket. It is fair to add, however, that many farm horses are never blanketed and seem to get along just as well, Nature furnishing them with an extra thick coat of hair in such cases. In snowy time the balls should be knocked out of the horse's feet and the snow cleaned out of the hair near the feet when the horse comes in for the night.

In winter, notice the difference in the hair of horses that are blanketed and those that are not.

There are many ways in which a horse may be lamed. Fast driving over hard roads and down hills is likely to cause "knee-sprung" and "cock-ankled" horses. Many persons make the mistake of not having horses shod often enough. A little saving in blacksmith's bills may result in a greater loss in lame horses. The feet of a horse are second to no other parts of his body in importance.

**141. The Intelligence of Horses.**—Horses differ greatly in intelligence, but even the most intelligent cannot be wholly trusted. A horse will trot along a given road for years with confidence; but let a piece of paper blow

across his path and he may shy or bolt or run. The chief mental quality of a horse is memory. One unjust stroke of the whip or a blow of your fist, and the horse is no longer your friend. If you once forget to unfasten the holdback and let the horse get caught coming out of the thills, you may look for trouble ever after.

## SUMMARY

All horses are probably derived from one stock.—The finest horses were originally found in the East.—Four common types of horses are: trotters, draft horses, coach horses, and ponies.—The different types of horses are the result of various conditions of life and of direct selection and breeding.—Among those noted for speed are the Thoroughbred families, Hambletonian, Mambrino, and Morgan and Standardbred Trotter and Pacer.—Draft horses are the Percheron, English Shire, Clydesdale, Belgian, and Suffolk.—Popular breeds of coach horses are the French, German, and Hackney Coach.—Three common breeds of ponies are the Shetland, Northern Indian, and Bronco.—Horses are sensitive to unwise feeding and to hard usage. Care should be taken not to make them ill or lame.

## QUESTIONS

1. Why is the horse important to the farmer?
2. Has horse trotting been of use to the world? Why?
3. Why is it better to raise a blooded colt than a "scrub"?

# CHAPTER XVIII

## SHEEP AND SWINE

**142. Advantages of Sheep Raising.**—On many farms sheep may be raised with much profit. The sheep yields two valuable products, wool and meat. Both of these are always in demand. Sheep are valuable also to the soil in fertilizing pastures on which they feed, as well as in destroying weeds and underbrush. They can feed and be well nourished where cattle would find insufficient feed. They also eat a great variety of feed. In some ways, however, they are rather dainty feeders; they will not do well on stale feed. Wool of even quality is not produced unless conditions of feeding and care are good.

Experiments with sheep and cattle have shown that it costs less to add a pound of mutton to sheep than it does to add a pound of beef to cattle. Cattle eat less per thousand weight than sheep, but they do not gain so large a percentage of their feed. At the Ohio Experiment Station it was shown that it took 8.9 pounds of dry matter in feed to produce one pound of increase in live weight in cattle, and 7.37 pounds to produce one pound increase in lambs.

**143. Breeds of Sheep.**—Sheep were formerly kept almost entirely for their wool, and so the breeds are

classified as short-wooled, medium-wooled, and long-wooled. The principal short-wooled breed in the United States is the Merino. It is represented by several families, the most familiar being the American, Delaine,

DAVENPORTS. Long-wooled breed.

and Rambouillet. The Merinos originated in Spain, and it is said that the robes of Roman emperors, two thousand years ago, were made from the fine wool of Merinos. The American produces a very fine wool on a very wrinkled body. It does not produce very good mutton. The Delaine has a smooth body and its wool is slightly longer and coarser in fiber than that of the American Merino, well adapted to carding. From this wool a fabric called Delaine is made. The Rambouillet is a French breed derived from Merinos imported from

Spain. It is the largest of the Merinos, and is raised for mutton as well as for wool.

Among the medium-wooled breeds may be mentioned the Southdown, Shropshire, Dorset Horn, Hampshire, and Oxford. The Southdown is a thick-set sheep, hornless, with face and legs of a grayish-brown color. It is the smallest of the "Down" or medium-wooled breeds. It is much raised for mutton. Individuals weigh one hundred and fifty to two hundred pounds, and produce a fleece weighing six to seven pounds.

The Shropshires are from the county of that name in England. The face and legs are darker colored than the Southdowns, and the Shropshires are heavier and yield more wool. They are much raised in the Mississippi Valley, being better adapted to withstand a wet climate than some others. Many common herds are crossed with Shropshires with good results. After the Merinos they are the great American sheep.

The Dorset Horn is one of the well-established breeds of England. In the United States it is kept in localities where the raising of lambs for the market is an important industry. It yields a rather light, short fleece.

The Hampshire is a black-faced breed, imported from England. It is hardy, a good grazer, and is widely scattered throughout Canada and United States. The lambs grow with great rapidity. The mutton is of good quality. The fleece is light, short, and inferior. The Suffolk Down is a large, black-faced, hornless, rangy sheep, originated in Suffolk County, England. It is a relatively recent introduction to America. The wool is of good quality and the mutton is excellent.

The Oxford is the largest of the medium-wooled sheep. It has a dark face and no horns. It is the sheep best adapted to feed on wet pastures. It is especially useful to produce mutton lambs to be marketed in early summer, at four to five months of age.

DORSET HORN SHEEP. Medium-wooled breed.

The long-wooled breeds, represented by the Cheviot, Leicester, Cotswold, and Lincoln, are not much raised in the United States. The Lincoln is one of the largest of all breeds, mature rams sometimes weighing two hundred and fifty pounds.

**144. Advantages of Raising Swine.**—Swine will change corn and other feed into salable meat in less time and at less expense than perhaps any other farm animal. They will consume waste products, and are a good side line on any farm. Much of this time they require very

little care. They also grub out the land and enrich it. For these reasons they are profitable stock to keep.

**145. Breeds of Swine.**—Swine are classified as large, medium, and small breeds. The large breeds are the Chester White, Large Yorkshire, and Tamworth; the medium breeds, Berkshire, Cheshire, Duroc Jersey, Hampshire, Poland China, and Victoria; the small breeds, Essex, Small Yorkshire, and Suffolk.

The Chester White is largely distributed over the United States. It can be made to gain a pound a day for two years, but 450 to 500 pounds is good weight. It

CHESTER WHITES.

is especially the fat hog or lard type, but makes fair bacon. It is grown especially in places where hogs are kept in pens instead of in the field.

One of the most popular breeds is the Poland-China, which originated in Ohio. The color is black and white, the white being confined to the four feet, the tip of the tail, and the nose, in good specimens. The face is dished and the nose of medium length. These hogs are popular because they are peaceable and strong-boned and fatten easily. They are of the lard hog type. It is not un-

usual for one to weigh two hundred and thirty pounds at six months.

In some parts of the United States the Duroc Jersey is a popular hog. The color varies from yellow to red,

POLAND-CHINA.

cherry red being the standard color. This breed is very hardy, prolific, good mothers, and with good disposition. There is more lean in their meat than in that of the Poland-China, but it is still of the lard type.

Perhaps no hog is more valued in America than the Berkshire, a fat hog type. The color is black, with white on face, feet, and tip of tail. The face is dished, and the ears generally carried erect. The body has good depth and strength. It is widely scattered throughout America. The quality of the meat is high.

The Cheshire should also be mentioned. "The color is white, head small and long, ears erect, hair thin, legs rather long, body long in proportion to the other dimen-

sions, bone fine." It is of American origin, and is of the fat hog type. The large Yorkshire, an English breed, is being raised where bacon hogs are in demand.

The small Yorkshire is widely raised, especially where hogs are kept in a pen. The nose is very short, and when the animal is fat the eyes are almost closed. It is generally killed and sold when it weighs about two hundred pounds. In feeding, it is generally "forced," or fattened as quickly as possible. It is a fat or lard hog, of little importance in America. The Suffolk closely resembles the small Yorkshire, and is of little importance in America. The Tamworth is a bacon hog, a golden red

Berkshires.

in color and little raised in United States. The Victoria, a lard hog, is also little raised here. The Essex is another small breed that is becoming popular. The color is black, face short and dished, hair thin, carcass long and deep. The animal easily takes on fat. The Hampshire, valued both for bacon and for lard, is characterized by

having a band of white encircling the body and including the fore legs.

**146. Where and How to Raise Swine.**—The hog has been well called the mortgage-lifter, and such it is in the great corn belt extending from Ohio to Kansas. The profit depends on the supply of cheaply grown corn and the ability of the hog to get about half the necessary feed by grazing. Where the latter condition is wanting the profits, at least in the West and South, will be uncertain. There should be good grazing ground, clean water, and shade. The source of the drinking water supply should not be a wallowing place. The shade in summer should be from trees rather than buildings in order that there may be a breeze. Hogs thrive better in small droves, and if many are kept it is better to separate them than to let them all run together. The breeding sows should be kept apart from the fattening herd.

Many keepers of hogs raise forage crops, such as clover, oats, vetch, cowpeas, and, in the South, sweet potatoes, peanuts, and chufa. It is better to raise a variety of crops on small tracts than only one kind. Some breeders have portable fences to control the feeding. Salt and ashes should be supplied freely, and frequent change of feed is desirable. When grain is fed it should not be thrown on soft ground to be trampled in the mud. Short and ground feed should be wet and fed in a trough. Shelters for hogs will vary with the latitude and climate, but in all cases it is better to have a floor. Many farmers use portable hog houses.

It is found to be cheaper to raise two hogs weighing three hundred pounds each than one weighing six hun-

dred pounds. Experiments have shown that three or four pounds of feed will add a pound to the weight of a hog under a hundred pounds, while more than five pounds of feed are required to put a pound of weight on a hog weighing over three hundred pounds. The most money is made by fattening as rapidly as possible, and if a hog is not gaining about a pound a day it should be sold. During the last six weeks corn is the best grain to feed. Young pigs should be taught to eat some grain and forage even before they are weaned. A few grains of soaked corn scattered on the floor will encourage them. Around the pen of the young pigs a plank should extend, raised a few inches from the floor to afford a protection for the pigs from their mother. Under this, soaked corn, shorts and oats may be scattered. Experiments have shown that the value of grain for hogs is increased if it is mixed with skimmed milk. Skimmed milk is not only a good flesh producer, but it also makes the grain more digestible. One bushel of corn and one hundred pounds of skimmed milk produced, in a certain test, fifteen pounds of gain when fed separately, and eighteen pounds when mixed and fed.

When raising hogs for the market one should raise pure-bred or at least high-grade animals. The pure-bred hog will weigh nearly twice as much on the same feed, and the loss in dressing will not be over twenty-five per cent, while the scrub hog will lose one third.

## SUMMARY

Sheep produce two valuable and necessary products—mutton and wool—and are a benefit to the land.—Breeds of

sheep are divided into short-wooled, medium-wooled, and long-wooled breeds.—The short-wooled breeds are represented by the Merinos, divided into the American, Delaine, and Rambouillet families in the United States.—Among the medium-wooled breeds are the Southdown, Shropshire, Dorset Horn, Hampshire, Suffolk Down, and Oxford.—The principal long-wooled breeds in the United States are the Cheviot, Leicester, Cotswold, and Lincoln.

The hog is a useful animal because it is easily cared for, fattened, and sold.—Breeds of swine are described as large, medium, and small.—Among the large breeds of swine are the Chester White, large Yorkshire, and Tamworth; among the medium breeds, the Berkshire, Cheshire, Hampshire, Victoria, Poland-China, and Duroc Jersey; among the small breeds the Essex, Small Yorkshire, and Suffolk.

## PROBLEMS

1. If ten lambs gain 0.45 pound each per day for 90 days, what is the total gain?

2. If the selling price was $4.75 per cwt., what was the total value of the gain?

3. If the average cost of feed per pound of gain was 2.93 cents, what was the profit on the 10 lambs?

4. These lambs were one year old at the end of the 90 days and averaged 125 pounds each. What were they worth?

5. The average weight of their fleece was 6.75 pounds, worth 11½ cents unwashed. What was the total value of the wool and the lambs?[1]

6. Ten pigs just weaned were fed the following amount during a period of 48 weeks: Corn, 772 pounds at 70 cents per hundred; shorts, 579 pounds at 65 cents per hundred; bone meal, 193 pounds at $1.50 per hundred; milk, 2,317 pounds

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[1] These examples are made from data contained in *Farmers' Bulletin* No. 96, "Raising Sheep for Mutton," and refer to actual experiments made at the Iowa Experiment Station in 1900.

at 15 cents per hundred. The total gain for the whole lot in 8 weeks was 533 pounds. (*a*) What was the cost of the feed for the eight weeks? (*b*) What was the cost per hundred of gain? (*c*) What was the gain worth at $6.65 per hundred? (*d*) What was the net profit on the 10 pigs, leaving out the value of the work and interest on money invested?

## CHAPTER XIX

### POULTRY AND BEES

**147. Benefits of Poultry Raising.**—Although the keeping of poultry is on the increase, yet there are many farmers who do not realize its advantages. Poultry raising differs from many other farm occupations in that most of the work is light and may make pleasant activity for the young folks or even for the women on the farm. In fact, many women are successful poultry raisers and make their living in this way. Poultry furnishes for the family an abundance of food that is easily prepared. The raising of poultry may be done on small places, as very little land is necessary. Poultry raising can be started with small capital, and even the best-blooded stock may be secured by small outlay for eggs of pure-bred fowls. Poultry furnishes a variety of products, as eggs for hatching and eating, broilers, and adult fowls of various kinds; and sometimes the feathers are a source of income. All these products are easily marketed. The certainty of a market is another good feature of the business, and at Thanksgiving and Christmas times the poultry raiser usually secures fancy prices. On the farm, much of the feed for poultry costs almost nothing.

Large numbers of insects are eaten by the poultry

A Rhode Island Poultry Farm.

as they range over the farm. This is especially true of turkeys, which eat locusts and crickets in great numbers, besides picking up the larvæ of many injurious insects. Where geese are kept the sale of feathers may be an item of special importance. It is customary to "pluck" the geese about four times a year. The feathers are heated and cleaned to make them ready for stuffing pillows and other articles. The feathers from other kinds of poultry are sometimes saved, but they are not so valuable.

The principal domestic fowls are chickens, ducks, geese, and turkeys.

**148. Breeds of Chickens.**—The breeds of chickens may be classified as egg breeds, meat breeds, and general purpose breeds. The principal egg breeds are Leghorn, Minorca, Black Spanish, Blue Andalusian, Ancona, and Houdan; the principal meat breeds, Brahma, Cochin, and Langshan; the principal general purpose breeds, Plymouth Rock, Wyandotte, Rhode Island Red, Java, and Dominique. Most of these breeds have two or more varieties.

The egg breeds are rather small, nervous, and lively. They are good foragers and are not inclined to sit. They like to run a good deal and should not be shut up too closely. The Leghorns are black, white, buff, or brown, and have large combs and wattles. The Leghorns are the most popular of the egg breeds. They lay white eggs and many of them. The Minorcas are somewhat larger, and are black or white. They have large, single combs. They lay well all the year round, and are fair table fowls. Houdans have a topknot of feathers, which

Brahma.

White Leghorn.

Buff Cochin.

Minorca.

Barred Plymouth Rock.

White Wyandotte.

STANDARD BREEDS OF CHICKENS.

some persons admire. They have five toes on each foot instead of four. They lay well, but are not kept to any great extent except for fancy purposes. They lay white eggs.

The meat breeds are less trim than the egg breeds, are not so active, lay fewer eggs, and are better sitters. The light Brahma is white with some black markings, and the shanks are feathered. There is also a dark variety. In addition to furnishing good meat these birds lay well, especially in winter. They are hardy and easily raised. The Cochins have most of the good qualities of the Brahmas. They are smaller, but are hardy and good winter layers. There are four varieties, black, white, buff, and partridge. The Buff Cochin is the most commonly bred. The Langshan is bred in two varieties, black and white. It has long shanks, fewer feathers, and is more upstanding than the others.

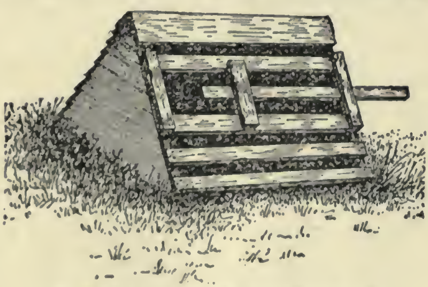
The general purpose breeds combine many of the characteristics of the egg and the meat breeds, so that they are good or fair layers at the same time that they furnish a good supply of meat. The Plymouth Rocks are probably the most popular of all and are bred in three varieties, Barred, White, and Buff. Perhaps the commonest variety is the Barred Plymouth Rock. The color is grayish white with blue-black lines running across the feathers throughout the whole length. The fowls are of medium size, smooth, and compact. They make good broilers at eight or twelve weeks of age, and lay the year round. The Wyandottes are somewhat smaller than the Plymouth Rocks, and their flesh is considered by some to be better. This breed is hardy and does well even when

shut up in a yard. There are several varieties. The other general purpose breeds are less popular in America.

**149. Ducks, Geese, and Turkeys.**—Ducks and geese also may easily be raised on the farm. Ducks especially require little care as they are not so liable to disease as are chickens, nor troubled so much by vermin, and much of their food is that which no other farm animal will eat. Their feed should be given in a softened condition, as they do not have a crop for softening it. Water plants, snails, and the young of insects are the natural feed of ducks. It is not necessary to have water for ducks to swim in, and many persons prefer not to let them swim. There are many breeds of ducks, among the more common being the Rouen, Pekin, Indian Runner, and Muscovey. The more popular breeds of geese are the African, Embden, Toulouse, Chinese, and Canadian.

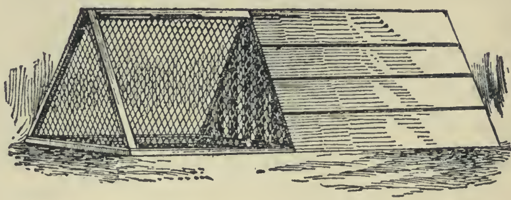
Turkeys bring the highest price of any meat from the farm, but more care is required in raising them than any other farm animal. There is, however, a sure market for them at certain seasons.

**150. Raising and Care of Poultry.**—Like everything else on the farm, poultry needs care and skill in raising if it is to be made profitable. Chickens should have a warm shed or house, free from drafts, in which to sleep and to stay in bad weather. They should



CHICKEN COOP WITH SLIDING SLATS.

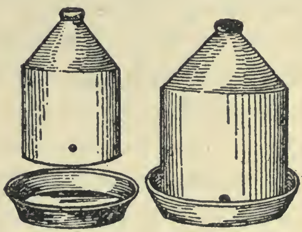
also have a scratching shed in which to exercise and a yard where they can run. If they are shut up, they



Chicken Coop with Inclosed Run.

must be provided with green stuff to eat, and there must be gravel and sand to eat and dust to roll in.

On farms there are many green things that would go to waste if it were not for the poultry: unsalable beets, potatoes, carrots, cabbage, lettuce, peas, corn, and poor specimens of fruit may well be fed to the chickens. In winter, roots and tubers are desirable.



Drinking Fountain Made of a Can.

Turkeys are exceedingly frail when first hatched, and until they are quite large they must not be allowed to go out and get wet in the early dews. At first, they do not know enough to eat, and some persons put a chicken in with the brood to furnish an example for the young turkeys. Very often food is stuffed into their mouths. Turkeys wander far away, especially to nest and rear their young; fence corners should be screened off to tempt them to stay nearer home. As the young get older and stronger,

they must have a large tract to feed on, and therefore they cannot be raised in towns and villages as chickens can.

151. **Bees.**—Bees get all of their food free of expense to the farmer; and though bees require considerable care, it is generally not expended in feeding them. Among the flowers on which bees feed may be mentioned the clovers, basswood, buckwheat, locust, milkweed, daisies, and other composite flowers, blossoms of fruit trees and shrubs, and cucumber blossoms in the vicinity of pickle factories, especially for fall feeding. Horse mint is an important bee flower in some sections.

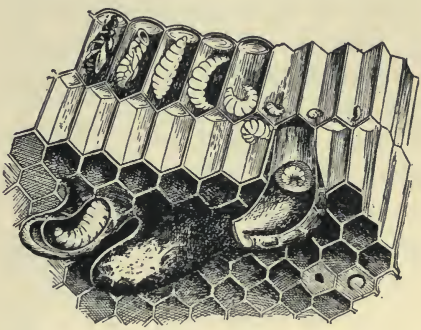

BEES. *a*, queen; *b*, drone; *c*, worker.

Each colony of bees contains a queen, workers, and drones. The queen lays all the eggs. The workers are imperfectly developed females, and gather honey, furnish wax and beebread, make the combs and fill them, and feed the young bees. The drones are the male bees and do no work.

The queen lays one egg in each cell and out of it hatches the young bee or larva. This little insect appears like a worm, and gets only what is fed to it. After a few days, the cell is sealed up and the larva spins a silken covering or cocoon about itself. Then after

about three weeks it comes out, an insect with wings. The queen lays her eggs in three kinds of cells. Out of the smallest cells come the workers. From the next size come the drones, and in a few of the largest cells are laid the eggs that are to produce queens.

At certain times the bees, or most of them, in company with the queen, having their sacs well filled with honey, rush forth from their hive and "swarm," as we call it. This swarming may be caused by the development of a new queen in the hive or by an oversupply of food so that there is no more space for them to fill, or by other causes we do not fully understand. After circling about in the air for a while they generally settle on a branch of a tree or brush near by. The bee keeper must then get them to settle in a new hive. Sometimes the hive is carried to the tree on which the bees have alighted, and if they are low enough they can be gently brushed in. More frequently the branch is cut off and carried to the hive, where the bees are gently shaken to the ground before the new hive and they find their way in. If, then, a little new or unfilled comb is found in the hive, something for them to go to work on, they will



Cells Containing Eggs, Larvæ, and Pupæ of the Honeybee. The lower large, irregular cells are queen cells. (After Benton.)

settle down and make it their home, and get to work. If bees are to be kept out of mischief, they must be kept busy. A modern way is to keep the queen's wings clipped so that she cannot fly away and will remain in the hive where she may easily be found and placed in the new hive. Then she is confined in a queen cage and the swarm that has come from the old hive clusters there. Some apiarists do not allow their bees to swarm, but either place additions on the hives to give more room or divide the swarm. In the hives are placed movable frames in which the bees place their comb and fill it with honey. These frames are then removed and others put in their places. Some apiarists sell the honey in the comb and others extract it. Shallow hives are of the Danzenbaker or Heddon type, while the deep hive is of the Langstroth type, holding perhaps ten frames.

When bees are carefully managed the yield of honey will average fifty to one hundred pounds a year from each hive. If the season is poor, owing to dry weather or other causes, or if the swarm is small, the bees may not make enough honey to carry themselves over winter, and the bee keeper has none. Professor Hodge reports a hive that gained thirty-two pounds in weight in a single day during the flow of basswood nectar. There is much water in this nectar which must be evaporated before it becomes honey. Bees should yield a profit of five to ten dollars a year for each swarm, but honey, like many

DIAGRAM SHOWING A BEE GETTING HONEY.

other articles produced on the farm, does not always come up to our expectations.

## SUMMARY

Poultry raising is mostly light work and yields good profits with small outlay when properly conducted. The work may be done on a small area. There is no farm industry, however, more likely to be a failure in the hands of the careless or untrained.—Poultry yields a variety of products for which there is always a good market.

The breeds of chickens are divided into egg breeds, meat breeds, and general purpose breeds.—The principal breed of the first group is the Leghorn; of the second, the Brahma; and of the third, the Plymouth Rock.

Ducks and geese are easily raised and feed on many things that other animals do not eat.

Chickens should have a warm shed for shelter and a sunny yard for scratching. They must be provided with green stuff and with grit to grind their food.

Turkeys require much care when young and often have to be taught to eat.

Bees are profitable and of little expense on the farm. The honey stored by them is a good commercial product.

## QUESTIONS AND PROBLEMS

1. In how many ways may poultry be valuable on a farm?

2. Why are winter layers the most valuable hens?

3. How would you tell a Minorca from a Houdan?

4. Why are ducks profitable fowls to raise?

5. In what respect do bees differ from the animals on the farm?

6. If eggs of a pure-bred hen for setting cost $1.50 per dozen, and common eggs 15 cents a dozen, and nine eggs of each lot hatch, how much more does each chick of the blooded stock cost than of the common?

7. If a common pullet is worth 45 cents and a pure-bred pullet 75 cents, do the better eggs pay? How much?

8. How many more eggs per year at 15 cents per dozen would the pure-bred hen have to lay to pay the extra cost of the egg from which she was hatched?

9. What is the value of a flock of 25 turkeys that dress on an average 13 pounds each, at 20 cents a pound?

10. A merchant "candled" eggs by looking through each egg toward a light and found two bad ones in each dozen, which were rejected. If the eggs that were not "candled" sold for 20 cents a dozen, how much must be charged for the "candled" ones to receive the same profit?

11. Why would it be more just to sell eggs by the pound than it is to sell them by the dozen?

12. What are the advantages in hatching chickens early in the season?

13. What is the profit from a flock of 15 hens, if each hen lays during the year 200 eggs selling at an average price of 20 cents a dozen, and if each hen eats one dollar's worth of feed per year?

14. If a hive of bees that costs $5 swarms once and makes 30 pounds of honey at 15 cents per pound, what is the profit?

15. On the first of May a hive of bees contains 20,000 immature and mature workers. If the queen lays 2,000 eggs each day during the month of May and 1,500 workers die each day, how many workers will the hive contain on the first of June?

16. Why is a swarm of bees in May worth more than a swarm in August?

# CHAPTER XX

## PRINCIPLES OF FEEDING AND CARE OF ANIMALS

**152. Importance of Animal Food.**—The animals on the farm are kept for certain definite purposes, as the horse for farm labor, the cow for milk or beef, the hen for eggs. We give them food and care in order that the results or products may be good. We might liken the animal to a machine by means of which the farmer gets certain products. The feed is the raw material from which the products are manufactured.

The products of the animal machine are: (1) heat; (2) new material to repair waste; (3) new material for growth; (4) eggs or young; (5) extra fat or other tissue and secretions; (6) energy in the form of muscular labor.

The raw material, as we have said, is the feed of the animal. In the case of milk, eggs, and flesh, the product of one animal may be the raw material of another; and all animals use the products of plants as raw materials. The product of the corn plant is grains of corn, which are the raw material for the cow; the product of the cow is milk, which is the raw material for the calf; and the calf, in turn, may become the raw material for human food in the form of veal.

The most important product, as far as the welfare of

the animal is concerned, is animal heat or energy on which all other life processes depend. When this is supplied the other purposes of the food may be accomplished. This means that the animal must be given more than just enough food to keep it alive if we want it to keep up in flesh, to grow, to produce wool, eggs or young, to give milk, or to do work.

Careful experiments have shown that it is a wasteful practice to keep colts and other young stock out of

Model Cow Barn, Showing Tie-up with Cement Floor and Tiled Walls and Ceilings.

doors in cold winters. It is useless to expect hens to lay eggs, or cows to give large quantities of milk, when suffering from cold. It may even pay to take the chill off the drinking water in cold weather. Exposure to cold demands that a large proportion of the animal's feed be used merely as fuel, to keep up animal heat; and unnecessary exposure lessens the use that animals can

make of their food for other purposes than body heat. Since energy is one of the important products to be gained from feed, it follows that an animal that works hard must have more feed than one that is idle.

**153. Classes of Feeds.**—It was stated in Chapter VII that three of the constituents of plants are protein, carbohydrates, and fat. All of the protein compounds contain nitrogen. They are especially necessary in the formation of bones and muscles. The fats and carbohydrates are useful in supplying the body heat and energy, and in storing up reserve materials for this purpose. The most important carbohydrates are starch, sugar, and fibers (Sec. 56). Sugar and starch are easily digested, but fibers are less easily digested.

Nearly all the feed of animals is classified in these three groups. Before anyone can use feeds intelligently, he must be able to tell into which class any feed falls. For example, corn contains ten per cent protein, five per cent oil, and seventy per cent carbohydrate, mostly starch, and is classified as a carbohydrate, since the carbohydrate compounds so greatly predominate. In making up a ration intelligently, therefore, the stockman must know how to choose his foods to get a proper balance with the protein requirements of the animal. (Complete tables showing the composition of feeding stuffs will be found in the Appendix.)

The following is an account of the feed of "Yeksa Sunbeam" (Sec. 120) during the test.

During grazing season, excellent blue grass and clover pasture was supplied. In the late fall and spring of the year this was supplemented with some clover hay as roughage. In July

and August, 1905, during hot weather and fly time, oats and peas in the green state were fed as soiling crop, followed, in August and September, by green corn. During the winter season, while stabled, was fed from 25 to 30 pounds of corn silage made of corn that was planted so close together that the ears did not develop; also good clover hay and part of the time some alfalfa hay. Off and on during the winter she was fed some rutabagas.

The grain feed consisted of a mixture of grain made up of four parts wheat bran, two parts ground oats, two parts gluten feed, one part Old Process oil meal. During the months of January, February, and March there was added to this mixture one part of corn meal. During the months of October, November, and December, 1904, she was fed 15 pounds a day of this grain mixture. During January, February, March, and April 14 pounds a day were fed; during May, 12 pounds; and during June the quantity varied from 12 pounds to 6 pounds. For July, August, and September she was fed 2 to 10 pounds of this grain mixture.

**154. Balanced Rations and the Nutritive Ratio.**—All animals require protein, carbohydrates, and oil or fats in the proper proportion; and skill in feeding consists in part in giving the feed in that proportion. A ration is a certain fixed portion of food dealt out to a person or an animal. When an animal's feed has the proper proportion of these three classes of foods for the purpose intended, it is said to be a *balanced ration*.

In balancing a ration and finding the *nutritive ratio*, the proportion of protein is compared with the proportion of carbohydrate and fats combined, and this comparison is generally written thus: 1:7, 1:12, indicating that there is one part of digestible protein to seven, or one part to twelve of digestible carbohydrates and fats,

or "carbohydrate equivalents." By carbohydrate equivalent is meant the carbohydrate (starch, sugar, and fiber) and fat expressed as an equivalent value of carbohydrate as an animal food. Fat is worth $2\frac{1}{4}$ times as much as carbohydrate. Thus, 8 pounds of fat would be worth $2\frac{1}{4}$ times 8, or 18 pounds of carbohydrate. If a ration had 12 pounds of starch and 4 pounds of fat, the carbohydrate equivalent would be $(2\frac{1}{4} \times 4) + 12$, or 21.

If this ration had also 2 pounds of protein, the *nutritive ratio*, that is, the ratio between the protein on the one hand and the carbohydrate equivalents on the other, would be 2:21 or 1:10.5. This would be called a "wide" ratio because there is such a predominance of carbohydrates; 1:5 would be called a "narrow" ratio.

For horses at work, the nutritive ratio should be about 1:6 to 1:7, the former being for heavy work. For milch cows, the average of 128 Wisconsin herds is given as 1:6.9. This is generally considered rather wide, and a ratio of about 1:5.4 is preferred for milch cows by many authorities. Wool sheep require a ration about 1:8 or 1:9. Similar standards are set for other classes of animals. (See Table IV, Appendix.)

The table on page 250 of the Appendix gives the amounts of the different classes of feed constituents in various fodders. The last column of Table VI gives numbers representing the energy value (that is, the value in producing energy) of feeding stuffs in calories.[1]

[1] A calorie is the amount of heat required to warm one pound of water four degrees Fahrenheit; or in the metric system, one kilogram of water one degree centigrade. Such a unit as this has been

In calculating the energy value of feeds, it is customary to consider that one pound of protein or carbohydrate produces 1,860 calories, and that one pound of fat produces 4,220 calories.

The following may be taken as a sample ration for a 900-pound dairy cow:

12.5 pounds timothy hay,
7.5 " corn fodder,
3 " corn meal,
4 " wheat bran,
2 " cotton-seed meal.

By reference to Table VII of the Appendix the following results may be obtained:

| | Total dry matter. | Protein. | Carbohydrates, etc.[1] |
|---|---|---|---|
| 12.5 pounds timothy hay | 10.9 | 0.35 | 5.8 |
| 7.5 pounds corn fodder, dry | 4.3 | 0.19 | 2.7 |
| 3 pounds corn meal | 2.6 | 0.19 | 2.1 |
| 4 pounds wheat bran | 3.5 | 0.48 | 1.8 |
| 2 pounds cotton-seed meal | 1.8 | 0.80 | 0.8 |
| Total pounds | 23.1 | 2.01 | 13.2 |

The other 7.89 pounds of dry matter is indigestible. The nutritive ratio of this ration is found by dividing 2.01 and 13.2 by 2.01. The quotients are 1:6.5. The number of calories found by multiplying 2.01 + 13.2 by 1860 is 28,290.

found the most convenient with which to measure energy. It is becoming customary to use the word *therm* to denote 1,000 calories, as it allows the use of smaller numbers.

[1] The "etc." in the table refers to the fat which has been reduced to carbohydrate equivalent by being multiplied by 2¼.

By substituting red-clover hay for the timothy, there would be a gain of 0.54 pound of protein, making the protein 2.55 pounds, with a loss of only half a pound of carbohydrates. This change would make the ration conform more nearly to the Wolff-Lehman standards as shown by Table IV in the Appendix.

**155. Kinds of Feeding Stuffs.**—For horses and cattle there is a great variety of feeding stuffs, roughly divided into green fodders, silage, hay, and dry coarse fodder, roots and tubers, grains and other seeds, mill products, and by-products. Only a few kinds will be mentioned under each head.

A Silo.

Green fodders consist of corn, rye fodder, oat fodder, oat grass, and the various well-known grasses, as redtop, orchard grass, timothy, alfalfa, and the clovers. Ensilage or silage (Sec. 104) may be of corn sorghum, soy beans, red clover, cowpeas, or certain other crops. Coarse fodder or "roughage" consists of dried corn fodder, barley hay, oat hay, and all the common forms of grass hay, and straw. Roots and tubers may be turnips, carrots, beets, or potatoes. The grains commonly used are corn, barley, buckwheat, peas, oats, rye, and wheat.

Mill products are corn meal, corn and cob meal, ground corn, oats, wheat bran, wheat middlings, rye bran, buckwheat bran, and buckwheat middlings. By-products are barley screenings, shorts, millet sprouts, brewer's grains, gluten feeds, hominy chop, linseed meal, cotton-seed hulls, meal, and the like. Other miscellaneous feeds are cabbage, sugar-beet pulp, beet molasses, apple pomace, skimmed milk, and the like.

It will be seen by reference to Table V of feeding stuffs in the Appendix that the grains have the largest amount of feed value per pound. For this reason they are sometimes called *concentrates*. The feed is so concentrated that it is necessary to feed roughage, as hay or straw, because the grains are not bulky enough to enable the animal's digestive apparatus to do its work properly.

The value of feed for heating the animal and for giving strength or energy to work is measured in calories. A horse at moderate work requires about 27,600 calories. In figuring a ration, it is customary to compute the necessary protein and the number of calories. Let us figure a ration for a 1,000-pound horse at moderate work. According to Table IV such a horse requires 2 pounds of protein and 27,600 calories. (Found by multiplying the carbohydrate value of the ration (14.85) by 1860.) Try

12½ pounds of timothy hay,
8 " of oats,
4 " of corn.

From the convenience table on page 254 we get the following contents:

| | Protein, | Carbohydrate, etc. |
|---|---|---|
| 12½ pounds timothy hay....... | .35 | 5.8 |
| 8 " oats............... | .74 | 4.6 |
| 4 " corn............... | .25 | 2.9 |
| Total .................... | 1.34 | 13.3 |

The nutritive ratio, found by dividing each quantity by 1.34, is 1:10, nearly. Multiplying the sum of the proteins and carbohydrates, etc., 14.64 by 1,860, we get 27,230, the number of calories of energy. The amount of protein is slightly under that given in the table, but is more nearly that actually fed to horses in the United States.

**156. Profit and Loss in Feeding.**—The main object in raising stock on the farm is to make money. All feeding should be done with the question in mind, "How much more will this feed be worth when changed into flesh or milk or other products, than it is now worth in its present shape?" If a costly feed is used when a cheaper would do just as well, there will be less profit, and perhaps a loss. The farmer should find out just how much and what is profitable to feed, and should use that and no more. Feeding tables based on thousands of experiments have been published, extracts from which will be found in the Appendix.

It will be seen from Table IV that the feed of oxen at rest in the stall should have a wide ration, 1:11, while that of milch cows should have a narrower ration, 1:6; and horses on light work 1:7, and on heavy work 1:6.

It is to be understood that many farmers feed stock without knowing these things. Thousands of farmers

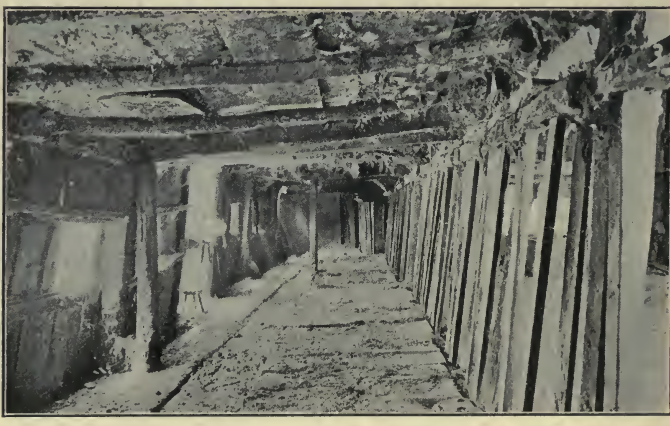
raised and fed stock successfully, learning by their own mistakes and experience, before these tables were made out. So they mowed with a scythe and cut grain with a sickle. But in the matter of feeding, just as in mowing and reaping, it is better and cheaper to learn by other persons' experience and progress, and the farmer should be glad to learn all he can about economical feeding of his stock, for whatever purpose. He does not wish to make the horse fat or the hog active; he does want, with the least expenditure of feed, to make the hog fat and the horse strong. It is well for a feeder of animals to know how much is being fed. Many persons feed twenty or thirty pounds of hay to a horse besides his grain, when ten or twelve is all that is necessary. It is well for one to know how near the standard he is feeding.

If the pupil lives on a farm he should conduct a series of experiments in feeding. He may figure out a balanced ration for certain animals. He should weigh the feed, for he should at least learn the quantity being fed. If it is possible to weigh some animals at intervals, much interest and profit may arise from the work.

**157. Care of Animals.**—Nearly as much depends on the proper care of farm animals as on the proper amount of feed. As was said at the beginning of the chapter, the first use of feed in cold weather is to keep the animal warm. If an animal is not properly protected and kept warm, the feed that should go to lay on fat, or increase the size and strength of the animal, or produce a product, is burned up for fuel. Many persons in the Northern States let colts run out all winter, but it has been found that such colts suffer in size and vigor.

Animals should also be kept clean. In some states there are now laws forbidding the sale of milk from filthy stables. Almost everyone curries horses; as a matter of fact, currying does cattle just as much good.

There should be a proper allowance of room and fresh air for animals. A great many barns are too open and subject to draughts, while in others the stock is



TIE-UP WITH DIRTY, DEFECTIVE FLOOR, CEILING, AND BACK.

crowded and the tie-ups are filthy and poorly ventilated. Animals need exercise also. Some years ago a Wisconsin farmer built a barn with the stables in the basement, expecting to keep the cattle there all the year round. He fed shredded corn. Finding after a few months' trial that most of his cows suffered from foot-rot, he decided to observe and follow nature a little more closely.

## SUMMARY

The animal uses feed for maintenance, to produce heat, repair waste, and build up tissue. When these are satisfied, the surplus may be turned into work or production.

Feed may be classed as of three kinds according to its nature: protein, fats, and carbohydrates.—Fats and carbohydrates produce fat and energy, and protein produces muscle and bone.

An animal should have a certain amount of each kind of feed. The proper amount is called a balanced ration.—A balanced ration may be found from various kinds of feeding stuffs.

Animals are producers of energy. If energy is lost, there is less profit from the animal. The source of energy is the feed the animal eats. If the animal is not cared for or protected from the cold, energy is wasted.—The farmer should strive to save the energy produced by the animal.

## QUESTIONS

1. Explain why an animal may properly be called a machine.
2. What are the raw materials of this "machine"?
3. Name some of the finished products.
4. Why should a cow be kept comfortably warm?
5. What are the three classes of feeds?
6. What is a balanced ration? Why is it important that an animal should have a balanced ration?
7. Which is the wider nutritive ratio, 1:6 or 1:12? What do these numbers mean?
8. Why is a hundred pounds of corn worth more than a hundred pounds of green fodder?
9. What is the nutritive ratio of the following ration for a horse? 7.5 pounds mixed hay, 8 pounds oats, 4 pounds corn and cob.

## CHAPTER XXI

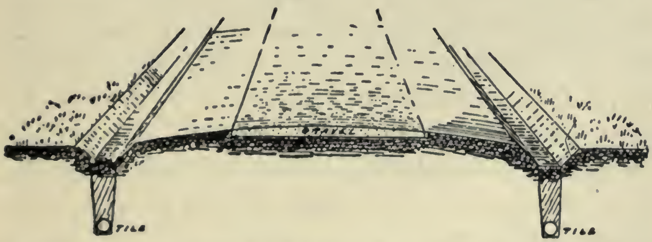
### GOOD ROADS.—FORESTRY.—HOME AND SCHOOL GROUNDS

**158. The Farmer's Interest in Good Roads.**—One of the most important things in connection with life on the farm is a good road. On the road the farmer must transport his produce to market, draw back his supplies, and travel to mill and to "meeting." Nothing contributes so surely to dislike of country and farm life as poor roads. The farmer plodding along in the mud, his team barely able to drag the load with harness, horses, and wagon a mass of dirt, pictures to himself his more fortunate brother in the city, using paved streets and cement walks. He decides that he has had enough of farming, sells or rents the farm, and departs for the city. It is unnecessary to enlarge the picture; it is too well known. During many days or even weeks of the year, the farmer and his family are shut away from town, from church, society, and entertainment. A large part of the trouble comes from the fact that most of the work on the roads has had only temporary effects.

**159. How to Make and Keep a Road Good.**—Scraping a lot of sand and dirt and sod and rubbish into the road and leaving it for the passing teams to flatten never did, and never will, make a good road. If a large part

of the work and money spent in the last twenty-five years in repairing and making dirt roads had been expended in doing a little each year and doing it well, every county in the Northern States might to-day have had its main thoroughfares in good condition. Much of the work done has really accomplished no good whatever to the roads, and they are often worse after than before repairs. The work on roads should consist in making good gravel or stone roads which are permanent in their nature.

There are certain foundation principles that should govern road-making and maintenance. The man who oversees the work should have scientific knowledge of




A Gravel Road Properly Crowned, with Side Ditches and Tile Drains.

how to make and maintain a good road. The material of the road should be graded, with the coarsest at the bottom; and the successive layers should be well rolled, compacted, and filled in with finer material. The road should be well drained.

But most important of all is to have a few workmen constantly making repairs. The railroad companies have learned that the only way to keep their roads in

good repair is to have a "section gang" with a competent boss constantly at work. Nothing made by man will last forever without attention and renewal, and a road is no exception. When a road shows signs of becoming rutty, the material should be hoed or dragged into the ruts. A half-day's work at the right time will save several days' work later and may keep the road in good condition. The roadmaster should make it a particular point to examine the road in rainy weather. He should notice where the water collects and should fill in such places as soon as the conditions permit.

The material of which the roads are made will depend on the locality and the financial condition of the inhabitants. Where it is possible, crushed stone should be used and a macadamized road built. In some states, the state assists and frequently builds a sample stretch of road as a model. Many miles of such roads have been built in Massachusetts. Where it is not possible to build stone roads, gravel may be used. There is a great difference in gravel roads, according to the kind of gravel and the plan of construction.

Much improvement might be made in roads with little trouble if country boys would form the habit of kicking or throwing loose stones out of the road. These loose, round cobblestones are a great nuisance in roads. Another way to keep roads good is by using only wide-tired wagons for heavy work and avoid driving in a single track.

The sides of the road should also receive attention; the brush and weeds should be cut and burned, not left as a harboring place for insects. The large stones should

be removed, so that the roadside may be used for sleds and cutters when the snow melts or blows off the main part of the road. Attention should be given to the drainage so as to avoid pools of standing water which keep the road from drying out in spring and after rains. Fences should be kept in repair.

Acquire the habit of observing the roads traveled and of noting the condition and reasons for the good or bad condition.

**160. The Purpose of Forestry.**—Forestry is the art of so managing growing timber that it may be used continuously for the needs of man. It includes not only raising and care, but the handling of the grown crop, its product, and waste material. When the first settlers came to this country they found an almost unlimited amount of forest land. Four hundred years of careless cutting have so devastated our forests that, unless some heroic efforts are made, forests will soon be no more. For this reason, the subject of forestry has recently been receiving much attention.

In forestry we study the conditions and length of time necessary to produce a forest, the best way to use and not to destroy a forest, and methods of reforesting "cut-over" lands. Forestry includes also the study of the effects of forests on climate, including the winds, temperature, humidity of the air, rainfall, drainage, and other effects on the soil. The purpose of forestry is not to prevent the death or destruction of trees, for all trees must die, but to determine when to cut a tree so that it will be of most value to the owner, and will leave its place in the best condition to be occupied by other trees.

**161. Some Advantages of Forests.**—It is now known that forests have an important influence on the climate. The air in a forest is some degrees warmer in winter and cooler in summer than the air in the open. The air in the forest is more nearly saturated with water than the air outside. These three conditions must affect more or less the surrounding region. The trees and the

A Deforested Hillside.
This shows how the rain water runs off carrying the soil with it.

dead leaves on the ground catch the rain and hold it so that it does not run off so rapidly as it does outside, and thus floods are checked. Equalizing the flow of streams is a most important influence of forests. Forests hinder evaporation from the soil to a very great extent, depending on the amount of leaf mold on the ground. As a wind break the forest is very important in some places.

It has been claimed by many that forests directly increase the rainfall in the United States. On this point Pinchot's "Primer of Forestry," published by the United States Department of Agriculture, says: "The best evidence at hand fails to show a decrease in rainfall over the United States in the last hundred years, in spite of the cutting and burning of immense areas of forests; but it should not be forgotten that most of those areas have grown up again, first with brush and afterwards with trees. It is believed, however, that more rain falls over forests than over open country similarly placed; but how much it is impossible to say."

**162. What Other Nations are Doing in Forestry.**— Almost every nation is doing something in the way of public forestry. Japan supports an efficient body of foresters and has a forest school. Government forestry is well established in Austria, Italy, Norway, and Sweden. The same is true in Turkey, Greece, Spain, and Portugal. Probably the most perfect system is in Germany, where there are seven forestry schools. The forests yield the nation a great income. France, also, has an effective system by which destructive floods have been prevented by the planting of trees.

Switzerland has one of the best systems in Europe, especially as a pattern for the United States. Forestry has been practiced there for six hundred years, and the public forests yield an annual return of about eight dollars per acre. The Swiss laws "Are intended to work more thorough instruction, good example, and encouragement than by severe regulations."

The forests in India under British control are in charge of 300 superior officers and 10,000 rangers, and yield an annual net income of over $3,000,000. It is said that 30,000 square miles are protected against fire at a yearly cost of less than half a cent per acre.

**163. What Our Government is Doing.**—There are in the United States more than 500,000,000 acres of forests. For somewhat over one hundred years the United States has made some effort to preserve the public forests. Even as far back as 1653, "the authorities of Charlestown, Mass., forbade the cutting of timber on town lands without permission." In 1799, Congress appropriated $200,000 for the purchase and preservation of timber land to supply ship timber for the navy. In 1891, an act was passed which was the first step toward a true policy for the forests of the nation. This act contained a clause which authorized the President to reserve timber land on the public domain. There are now sixty-two such reserves of public timber lands, covering an area of 62,000,000 acres. Their use is to protect drainage basins used for irrigating, supply grass and forage for herds of cattle, and supply wood and lumber for settlers.

Forest Service is the name of the forestry branch of the United States Department of Agriculture. The "Service" is making a map of the distribution of tree species in the United States, studying the value of different trees, such as those producing tanbark, willows for baskets, and pines for turpentine. The officers are supervisors, rangers, and guards, with deputies. Owners of timber land are given advice in regard to the best

methods of managing their forests. A study is made of forest products and the extension of forests.

**164. How a Forest May Be Perpetuated.**—Several methods are in use to perpetuate a forest. One method consists in dividing it into small sections and cutting one section clean each year. New trees, self-sown, will grow up; and after many years the forest will consist

A FOREST PROPERLY LOGGED UNDER THE FOREST SERVICE REGULATIONS. The young growth is uninjured and the brush is piled ready for burning.

of areas in which the trees differ in age by one year. For example, it is found that certain trees will grow large enough for railroad ties in thirty-five years. By dividing a forest into thirty-five tracts and cutting off one tract each year, the supply could be made per-

petual. Sometimes the trees for cutting are selected from the whole forest, the same ground being gone over year after year. Sometimes a strip one hundred yards wide or thereabouts is cut out and then allowed to grow up again.

Become acquainted with the trees in your vicinity and know the names of some of them.

**165. Home and School Grounds.**—Many schoolhouses and some farmhouses are situated on plots of ground that are destitute of trees and shrubs. The sun beats on the buildings in the summer and the wind is unbroken in the winter. Nothing but barrenness is visible. If the objects that are daily seen impress our lives and help to form our characters, then here is an opportunity to impress beauty rather than its opposite quality.

The work in school agriculture ought to create a desire in the pupils to clean up and beautify the home and school grounds. From the neglected yards the tall grass and weeds should be mowed, and the large weeds pulled up by the roots; the dead leaves and weeds should be raked into piles, the other rubbish gathered up, and all burned or removed. Grass seed should then be sown. Even if nothing further is done, most premises will repay such work by their improved appearance.

**166. Trees and Shrubs.**—Trees and shrubs look better, as a rule, when planted in groups or clumps, rather than scattered singly around the home or schoolhouse. Landscape gardeners say that the larger trees

and shrubs should be in the background as a setting for the buildings, with low shrubs near the buildings and open spaces with grass in front. Often trees or shrubs can be used on the boundaries in place of unsightly fences. It is a good plan to use trees or tall shrubs to hide the unsightly parts of buildings and outhouses. In selecting trees, find some that are hardy and will live readily in your locality. Some trees grow rapidly but will not live long, and usually prove unsatisfactory. The American white elm (not the red elm) and the hard maple (not the soft maple) are two standards for most localities. The basswood, or American linden, is a desirable tree because it grows rapidly and is also hardy. The blossoms are visited by honeybees, which make excellent honey from the nectar in them. The ash trees are quite satisfactory in the Northern States, as are also the sycamore, mulberry, walnut, Norway maple, horse-chestnut, and beech. For places in the South the catalpa, tulip tree, the cucumber tree and the sweet gum may be added to the list. If the buildings need protection from the winter winds, then evergreen trees make a good wind-break. The Norway spruce is quite satisfactory for this purpose; the Colorado blue spruce is perhaps more ornamental but not quite so vigorous in all climates. The blue spruce is often used as an ornamental tree. Directions for transplanting trees were given on page 154.

In choosing shrubs, choose hardy ones. Wild shrubs that grow in the locality are often the best for the purpose. Often there is some one in the neighborhood or district who has had experience in growing shrubs in his

home yard. Such a person will generally be glad to help in choosing suitable shrubs, and sometimes can supply the plants from his own yard. Do not depend entirely upon the descriptions in catalogues, or upon the advice of agents who are canvassing for shrubs and trees. Set out principally such shrubs as experience has shown will grow well in your locality.

Some of the shrubs that are used in many localities and have proved satisfactory are species of spirea, barberry, honeysuckle, weigela, lilac, snowball, double-flowering crab or plum, mock orange, sumach, dogwood, and currants. There are many different species of these shrubs, some being better adapted to one purpose and others to different ones. If it is desired to form a hedge, the common barberry, lilac, bush honeysuckle, arborvitæ, elderberries, or others similar in character, will be found suitable. If there is a corner that can be filled with shrubs, tall ones should be set out in the rear and low ones in the front. The Japanese barberry is a pretty dwarf variety, and Waterer's spirea is very desirable as a low shrub, while the rose-colored weigela, tartarian honeysuckle and mock orange are taller and suitable for places in the background.

**167. Vines.**—There are many climbing plants that can be used to make a yard beautiful. This is especially true around porches, over the doors, along walls, on arbors, or to cover unsightly objects. Climbing roses, clematis, Virginia creeper, bittersweet, English ivy, Boston ivy, climbing honeysuckle, wistaria, trumpet creeper, and wild grapevine are all suitable for use. A word of caution is needed here, as well as at all points

in gardening, that care must be exercised in the arrangement of the plants, or the results will be unsatisfactory. Each vine has its own beauty, determined by its form, leaves, and blossoms. The effect desired in any given place must determine the kind to be planted. There are a number of annual climbers that may be used in some places with good effect, such as morning-glory, wild cucumber, cinnamon-vine, moon-vine, and Madeira.

**168. Flower Garden.**—Flowers should be raised in the garden or close to the sides of the house, but not in front or in beds on the lawn. It is as a rule better to leave the lawn directly in front of the house clear of trees, shrubs, and flowers, but at the sides and rear trees and shrubs may be arranged according to some plan, and the shrubs may be bordered with flowers.

One of the most interesting flower beds may be made from the native flowers which grow in the vicinity. If a shady corner can be found, ferns make a very satisfactory background near buildings. Violets will usually thrive if transplanted with care; bloodroot, anemones, hepatica, spring beauties, pasque flowers, columbine, and many other flowers can be added. Ferns often can be added to such a bed with good effect. This is an excellent flower bed for a school yard, as the children can dig up the specimens for the bed and tend to them as they grow. The blossoms also will appear early in the spring, before the vacation begins.

Old-fashioned flowers can be grown with satisfaction in the flower garden. Hollyhocks, phlox, dahlias, sunflowers, pinks, nasturtiums, stocks, verbenias, mignonette, larkspur, and candytuft represent a partial list

from which selections may be made. These are more suitable for the flower garden at home than at school. Some of these are suitable for borders along walks where shrubs are used in the background.

In place of sowing seeds as for the above-named plants, bulbs may be set out. A bulb is a short underground stem having buds and many scales, which represent leaves. Many of the early-flowering plants come from bulbs, in which much food has been stored in the scales. The crocus is the earliest of these plants to bloom out-of-doors in the spring. The hyacinths, tulips, narcissi, and lilies are very satisfactory. These bulbs should be planted in the ground in the autumn before the ground freezes. They will be ready to start with the first warm spring days. If the winters are very severe it may be best to cover the ground with leaves to protect the bulbs.

The most satisfactory flower gardens are those that are laid out in accordance with approved plans. There is as much opportunity for the display of good taste in this matter as in the furnishing of the inside of the house. Landscape gardening is being studied by many persons, and more and more grounds are being planned so as to produce a harmonious effect with the building and its surroundings.

There are many hardy plants that may be used in clumps in place of the bedding plants. The bedding plants must be renewed every year, and it is always late before they can be started. The hardy ones live over the winter, and increase from year to year. The investment here is a permanent one, while the other

plants must be renewed each year. The hardy plants are much easier of cultivation than the bedding plants. A list of herbs and shrubs is given by a landscape gardener:

## HARDY PERENNIALS FOR THE FARMER'S FLOWER GARDEN

Aconitum autumnale (Monkshood).
Aquilegia (Columbine).
Althea (Hollyhocks).
Delphinium formosum (Larkspur).
Dicentra spectabilis (Bleeding Heart).
Funkia subcordata (Plantain Lily).
Hemerocallis flava (Lemon Lily).
Iris Germanica, named varieties (especially Florentina, Madame Chereau, and Silver King).
Lilium superbum.
Monarda didyma (Bergamot).
Peonies, Chinese (especially Festiva Maxima and Lady Leonora Bramwell).
Papaver orientale (Oriental Poppy).
Platycodon grandiflora.
Phlox decussata (especially Lothair and Miss Lingard).
Pyrethrum uliginosum (Great Daisy).
Rudbeckia (Golden Glow).

## HARDY FLOWERING SHRUBS BEST ADAPTED TO THE FARMER'S GARDEN AND LAWN

Chionanthus Virginica (White Fringe Tree).
Deutzia Lemoinei.
Hydrangea grandiflora.
Lonicera bella candida (Honeysuckle).
Philadelphus grandiflora (Syringa).
Spirea Japonica, variety "Anthony Waterer."
Spirea Thunbergii.

Spirea Van Houttei (Bridal Wreath).

Symphoricarpus racemosa (Snowberry).

Syringa vulgaris (Lilac), especially "President Grevy" and Frau Bertha Damman.

Syringa Japonica (Japanese Tree Lilac).

Viburnum opulus (High-bush Cranberry).

Viburnum opulus sterilis (Snowball).

Weigela rosea.

Weigela Eva Rathke.

The care of the flower garden is not materially different from that of the vegetable garden. The directions given there for the preparation of the soil and its subsequent treatment will also apply here. The soil should not be cultivated deep enough to disturb the roots, but the ground must be kept free from weeds.

Make a plan for improving the grounds about your schoolhouse, or some other building. Start the work.

**169. Conclusion.**—The carpenter or other mechanic works upon his material, wood, metal, leather, or fabric, and sees it change under his hand to a thing of use or beauty. But these materials are lifeless and passive. The farmer, on the other hand, is dealing with things that not only can he change, but they themselves have life and respond to his efforts, coöperating with him to produce every product of the animal and vegetable kingdoms.

## SUMMARY

One of the most important things to a farmer is a good road.—A good road is one that is hard and serviceable in all weather and seasons.—The way to have a good road is to build it right, of the right material, and to keep it in repair.

Forestry is the art of forming or of cultivating forests.—Forests are, next to the earth, the most important possessions of mankind. They affect the climate and water supply.—Nearly every nation in Europe gives much attention to forestry.—The United States has sixty-two forest reserves.

School agriculture should create a desire to beautify school and home grounds.—Generally the first thing to do is to rake up and clear away rubbish.—Shrubs and plants should be set out on the borders, leaving large open spaces covered with closely mowed grass.—Varieties of plants that are known to be hardy in a given locality should be set out.—Vines are useful for arbors, on walls, and to cover unsightly objects.—The flower garden is the place for flower beds rather than the lawn.—A bed of wild flowers is very satisfactory.—Old-fashioned flowers should have a place.—Bulbs yield early flowers.

# APPENDIX

## INSECTICIDES AND FUNGICIDES

### Bordeaux Mixture for Blights

The following directions for making Bordeaux mixture should be strictly followed to obtain the best results: Dissolve four pounds of copper sulphate (bluestone, blue vitriol) in twenty-five gallons of water, suspending it in a coarse gunny sack near the surface of the water. In a wooden pail slack six pounds of fresh quicklime in sufficient water, then add enough water to make twenty-five gallons and then slowly pour the two solutions simultaneously into the barrel from which it is to be used. If a larger tank is used, proportionately larger quantities of materials should be taken. Before pouring the lime solution, it should be strained through a coarse gunny sack, otherwise particles of rock and undissolved lime will get into the mixture and clog the nozzles in spraying. It is very important that the two ingredients be mixed as described, otherwise the proper combination of copper sulphate and lime does not take place.

The mixture should never be made more than a few hours in advance of application. It cannot be kept over; and if any is left in the spraying machine after the day's work is done, it should be emptied.

## How to Treat Seed Oats to Prevent Smut[1]

### *Formaldehyde Solution*

If the desire is to sow forty bushels of seed oats or less, secure from your druggist one pint of formaldehyde. Put into a barrel or tank thirty-six gallons of water and pour in the pint of formaldehyde liquid and stir thoroughly; next fill a gunny sack with the seed oats and submerge it in the solution for ten minutes; then lift the sack from the barrel and allow it to drain for a minute or two in order to save the solution. Empty the oats on a thrashing floor or on some outside platform to dry, and repeat until all is treated; shovel the treated grain over at intervals until dry or nearly dry before sowing.

If a large quantity of seed is to be treated the work will be facilitated by having several barrels or a large tank which will hold a number of sacks of oats, so as to treat several bushels every ten minutes. The time saved by having an abundant supply of the solution in the tank or barrels will more than repay the extra expense of the formaldehyde purchased. *The oats must always be completely submerged for ten minutes.*

It is well to treat seed grain several days before sowing in order to give it ample time to dry, or difficulty may be experienced when sowing with seeder or drill. If sown while damp the seeder or drill should be set so that it will sow about one bushel more per acre than when sowing dry oats.

The formaldehyde solution here recommended is not poisonous to farm animals and will not injure sacks or clothing coming in contact with it. Oats treated with formaldehyde solution and not used for seed may be fed to stock, but when so fed should be mixed with other oats.

The treatment of oats here recommended facilitates the

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[1] From "Oat Smut in Wisconsin," *Bulletin* 98, Wisconsin Agricultural Experiment Station.

sprouting and gives the grain a healthy appearance, readily distinguished by any observer. It is possible that the treatment kills other disease germs of which we as yet have no knowledge.

### How to Treat Scabby Seed Potatoes

"Make the proper solution by pouring one pint of formaldehyde into twenty-five gallons of water. Distribute the liquid into several casks and into these casks put the uncut seed potatoes. The potatoes should be placed in gunny sacks and completely covered by the liquid and left for two hours. If the potatoes are very scabby leave for two and a half hours. The potatoes should then be planted in ground that has not in previous years grown scabby potatoes."—*Wisconsin Experiment Station Bulletin.*

### Kerosene Emulsion

Kerosene emulsion contains the following ingredients:

| | |
|---|---|
| Soap | ½ pound |
| Water | 1 gallon |
| Kerosene | 2 gallons |

The soap is cut into thin shavings and dissolved in hot soft water, and this is then thoroughly mixed with the kerosene by being pumped back on itself with a force pump. Small quantities, as a quart or more, may be mixed with a "Dover" egg-beater. This emulsion is to be diluted fifteen to twenty times its bulk in the growing season, but in winter it may be used very strong for scale insects. If the emulsion sets it must be heated before dilution. Any good hard soap may be used.

### Paris Green

Paris green is used for all biting and chewing insects, the mixture being in the proportion of one pound of Paris green to 150 gallons of water. Paris green is frequently added to Bor-

deaux mixture. In this way plant diseases are prevented, and the ravages of insects are lessened by one spraying.

## TABLES

### Table I.—Soil Constituents Contained in Average Crops per Acre

*(From Tables of A. D. Hall, Director of Rothamsted Experiment Station)*

| Crop....... | | Wheat | Barley | Sweedes | Mangels | Hay |
|---|---|---|---|---|---|---|
| | Tons: | 2.2 | 2. | 30.1 | 30.1 | 1.5 |
| Nitrogen........ | Lb.: | 50.0 | 49.0 | 98.0 | 149.0 | 49.0 |
| Soda........... | Lb.: | 2.6 | 5.0 | 32.0 | 118.7 | 9.2 |
| Potash.......... | Lb.: | 28.8 | 35.7 | 79.7 | 300.7 | 50.9 |
| Magnesia........ | Lb.: | 7.1 | 6.9 | 9.2 | 42.5 | 14.4 |
| Phosphoric Acid. | Lb.: | 21.1 | 20.7 | 21.7 | 52.9 | 12.3 |
| Sulphur......... | Lb.: | 7.8 | 6.1 | 17.8 | 14.0 | 5.7 |
| Chlorine........ | Lb.: | 2.5 | 4.1 | 15.1 | 83.1 | 14.6 |
| Silica........... | Lb.: | 96.9 | 68.6 | 6.7 | 17.9 | 56.9 |

### Table II.—Fertility Removed by Different Crops[1]

| Kind of Crop | Assumed Yield Per Acre | Removes Per Acre, Lb. | | |
|---|---|---|---|---|
| | | Nitrogen | Phosphoric Acid | Potash |
| Corn (grain and stalks) ... | 60 bu. | 84 | 32 | 34 |
| Wheat (grain and straw)... | 30 bu. | 62 | 20 | 26 |
| Oats (grain and straw).... | 60 bu. | 60 | 22 | 50 |
| Clover hay.............. | 2 tons | 82 | 18 | 88 |
| Timothy hay............ | 2 tons | 50 | 20 | 60 |
| Tobacco (leaves only)..... | 1,600 lb. | 70 | 8 | 91 |
| Sugar beets, topped...... | 15 tons | 42 | 8 | 65 |
| Cabbages................ | 15 tons | 100 | 35 | 135 |
| Peas.................... | 15 bu. | 108 | 33 | 52 |
| Potatoes................ | 200 bu. | 33 | 20 | 62 |

[1] From *Bulletin* No. 134, University of Wisconsin Agricultural Experiment Station, "Licensed Commercial Fertilizers and Feeding Stuffs."

## Table III.—Space and Quantities of Seed Required

| Name | Space and Quantity of Seeds |
|---|---|
| Asparagus | 1 oz. produces 1,000 plants, and requires a bed 12 ft. square. |
| Asparagus Roots | 1,000 plant a bed 4 feet wide and 225 feet long. |
| English Dwarf Beans | 1 quart plants 100 to 150 feet of row. |
| French Dwarf Beans | 1 quart plants 250 to 350 feet of row. |
| Beans, pole, large | 1 quart plants 100 hills. |
| Beans, pole, small | 1 quart plants 39 hills or 250 feet of row. |
| Beets | 10 lb. to the acre, 1 oz. plants 150 feet of row. |
| Broccoli and Kale | 1 oz. plants 2,500 plants, and requires 40 sq. ft. of ground. |
| Cabbage | Early sorts same as broccoli, and require 60 sq. ft. of ground. |
| Cauliflower | The same as cabbage. |
| Carrot | 1 oz. to 150 feet of row. |
| Celery | 1 oz. plants 2,500 plants, and requires 40 sq. ft. of ground. |
| Cucumber | 1 oz. for 150 hills. |
| Cress | 1 oz. sows a bed 16 feet square. |
| Egg Plant | 1 oz. gives 2,000 plants. |
| Endive | 1 oz. gives 3,000 plants, and requires 80 feet of ground. |
| Leek | 1 oz. gives 2,000 plants, and requires 60 feet of ground. |
| Lettuce | 1 oz. gives 7,000 plants, and requires a seed bed of 120 feet. |
| Melon | 1 oz. for 120 hills. |
| Nasturtium | 1 oz. sows 25 feet of row. |
| Onion | 1 oz. sows 200 feet of row. |
| Okra | 1 oz. sows 200 feet of row. |
| Parsley | 1 oz. sows 200 feet of row. |
| Parsnips | 1 oz. sows 250 feet of row. |
| Peppers | 1 oz. gives 2,500 plants. |
| Peas | 1 quart sows 120 feet of row. |
| Pumpkin | 1 oz. to 150 hills. |
| Radish | 1 oz. to 100 feet. |
| Salsify | 1 oz. to 50 feet of row. |
| Spinach | 1 oz. to 200 feet of row. |
| Squash | 1 oz. to 75 hills. |
| Tomato | 1 oz. gives 2,500 plants, requiring a seed bed of 80 feet. |
| Turnip | 1 oz. to 2,000 feet. |
| Watermelon | 1 oz. to 50 hills. |

## Quantities of Seed Required to the Acre

| Name | Quantity of Seed | Name | Quantity of Seed |
|---|---|---|---|
| Wheat | 1½ to 2 bu. | Broom Corn | 1 to 1½ bu. |
| Barley | 1½ to 2½ bu. | Potatoes | 5 to 10 bu. |
| Oats | 2 to 4 bu. | Timothy | 12 to 24 qt. |
| Rye | 1 to 2 bu. | Mustard | 8 to 20 qt. |
| Buckwheat | ¾ to 1½ bu. | Herd Grass | 12 to 16 qt. |
| Millet | 1 to 1½ bu. | Flat Turnip | 2 to 3 lb. |
| Corn | ¼ to 1 bu. | Red Clover | 10 to 16 lb. |
| Beans | 1 to 2 bu. | White Clover | 3 to 4 lb. |
| Peas | 2½ to 3½ bu. | Blue Grass | 10 to 15 lb. |
| Hemp | 1 to 1½ bu. | Orchard Grass | 20 to 30 lb. |
| Flax | ½ to 2 bu. | Carrots | 4 to 5 lb. |
| Rice | 2 to 2½ lb. | Parsnips | 6 to 8 lb. |

TABLE IV.—AMOUNT OF NUTRIENTS FOR A DAY'S FEEDING

| Standard | Animal | Live Weight | Total Dry Matter | Digestible Nutrients: Protein | Digestible Nutrients: Carbo-hydrates | Digestible Nutrients: Fat | Nutritive Ratio[1] |
|---|---|---|---|---|---|---|---|
| | *Oxen* | lbs. | lbs. | lbs. | lbs. | lbs. | |
| Wolff-Lehmann | At rest in stall...... | 1000 | 18.0 | 0.7 | 8.0 | 0.1 | 1:11.8 |
| | *Fattening Cattle* | | | | | | |
| Wolff-Lehmann | First period........ | 1000 | 30 0 | 2.5 | 15.0 | 0.5 | 1: 6.5 |
| " | Second period...... | 1000 | 30.0 | 3.0 | 14.5 | 0.7 | 1: 5.4 |
| " | Third period....... | 1000 | 26.0 | 2.7 | 15.0 | 0.7 | 1: 6.2 |
| | *Dairy Cows* | | | | | | |
| | Milch cows, producing 16 lb. of milk per day.......... | 1000 | 27.0 | 2.0 | 11.0 | 0.4 | 1: 6.0 |
| | *Horses* | | | | | | |
| Wolff-Lehmann | Light work......... | 1000 | 20.0 | 1.5 | 9.0 | 0.4 | 1: 7.0 |
| " | Medium work...... | 1000 | 24.0 | 2.0 | 11.5 | 0.6 | 1: 6.2 |
| " | Heavy work........ | 1000 | 26.0 | 2.5 | 13.3 | 0.8 | 1: 6.0 |
| | *Growing Cattle* | | | | | | |
| | Dairy breeds | | | | | | |
| | (Age in months) | | | | | | |
| Wolff-Lehmann | 2–3 | 150 | 3.5 | 0.60 | 1.95 | 0.300 | 1: 4.5 |
| " | 3–6 | 300 | 7.2 | 0.90 | 3.84 | 0.300 | 1: 5.1 |
| " | 6–12 | 500 | 13.5 | 1.00 | 6.25 | 0.250 | 1: 6.8 |
| " | 12–18 | 700 | 18.2 | 1.26 | 8.75 | 0.280 | 1: 7.5 |
| " | 18–24 | 900 | 23.4 | 1.35 | 10.80 | 0.270 | 1: 8.5 |
| | Beef breeds | | | | | | |
| Wolff-Lehmann | 2–3 | 160 | 3.7 | 0.67 | 2.08 | 0.320 | 1: 4.2 |
| " | 3–6 | 330 | 7.9 | 1.16 | 4.22 | 0.495 | 1: 4.7 |
| " | 6–12 | 550 | 13.8 | 1.38 | 7.26 | 0.385 | 1: 6.0 |
| " | 12–18 | 750 | 18.0 | 1.50 | 9.38 | 0.375 | 1: 6.7 |
| " | 18–24 | 950 | 22.8 | 1.71 | 11.40 | 0.380 | 1: 7.2 |
| | *Growing Sheep* | | | | | | |
| | Wool breeds | | | | | | |
| Wolff-Lehmann | 4–6 | 60 | 1.5 | 0.20 | 0.92 | 0.042 | 1: 5.0 |
| " | 6–8 | 75 | 1.9 | 0.21 | 1.04 | 0.045 | 1: 5.4 |
| " | 8–11 | 80 | 1.8 | 0.17 | 0.92 | 0.040 | 1: 6.0 |
| " | 11–15 | 90 | 2.0 | 0.16 | 1.01 | 0.036 | 1: 7.0 |
| " | 15–20 | 100 | 2.2 | 0.15 | 1.08 | 0.030 | 1: 7.7 |
| | Mutton breeds | | | | | | |
| Wolff-Lehmann | 4–6 | 60 | 1.6 | 0.26 | 0.93 | 0.054 | 1: 4.0 |
| " | 6–8 | 80 | 2.1 | 0.28 | 1.20 | 0.056 | 1: 4.8 |
| " | 8–11 | 100 | 2.4 | 0.30 | 1.43 | 0.050 | 1: 5.2 |
| " | 11–15 | 120 | 2.8 | 0.26 | 1.51 | 0.060 | 1: 6.3 |
| " | 15–20 | 150 | 3.3 | 0.30 | 1.80 | 0.060 | 1: 6.5 |

[1] See note on page 249.

TABLE IV.—*Continued*

| Standard | Animal | Live Weight | Total Dry Matter | Digestible Nutrients: Protein | Digestible Nutrients: Carbohydrates | Digestible Nutrients: Fat | Nutritive Ratio[1] |
|---|---|---|---|---|---|---|---|
| | *Growing Swine* Breeding stock (Age in months) | lbs. | lbs. | lbs. | lbs. | lbs. | |
| Wolff-Lehmann | 2–3 | 50 | 2.2 | 0.38 | 1.40 | 0.050 | 1: 4.0 |
| " | 3–5 | 100 | 3.5 | 0.50 | 2.31 | 0.080 | 1: 5.0 |
| " | 5–6 | 120 | 3.8 | 0.44 | 2.56 | 0.048 | 1: 6.0 |
| " | 6–8 | 200 | 5.6 | 0.56 | 3.74 | 0.060 | 1: 7.0 |
| " | 8–12 | 250 | 6.3 | 0.53 | 3.83 | 0.050 | 1: 7.5 |
| | *Growing fattening Swine* | | | | | | |
| Wolff-Lehmann | 2–3 | 50 | 2.2 | 0.38 | 1.40 | 0.050 | 1: 4.0 |
| " | 3–5 | 100 | 3.5 | 0.50 | 2.31 | 0.080 | 1: 5.0 |
| " | 5–6 | 150 | 5.0 | 0.65 | 3.35 | 0.090 | 1: 5.5 |
| " | 6–8 | 200 | 6.0 | 0.72 | 4.10 | 0.080 | 1: 6.0 |
| " | 9–12 | 200 | 5.2 | 0.60 | 3.66 | 0.060 | 1: 6.4 |
| | Human beings | | | Protein | Carbohydrates and Fats | | |
| | Children, 6–15 yrs. | | | 0.16 | 0.93 | | 1: 5.2 |
| | Students | | | 0.20 | 1.11 | | 1: 5.5 |
| | Professional Men | | | 0.27 | 1.76 | | 1: 4.7 |
| | Man with moderate work | | | 0.28 | 1.62 | | 1: 5.8 |
| | Man with hard work | | | 0.39 | 2.67 | | 1: 6.9 |

[1] The nutritive ratio is obtained by multiplying the number of pounds of fat by 2¼, adding the product to the number of pounds of carbohydrates, and dividing this sum by the number of pounds of protein for the second term of the ratio. The first term of the ratio is 1.

TABLE V.—DRY MATTER AND DIGESTIBLE FOOD INGREDIENTS IN 100 POUNDS OF FEEDING STUFFS [1]

| FEEDING STUFF | TOTAL DRY MATTER | PROTEIN | CARBO-HYDRATES | FAT | FUEL VALUE |
|---|---|---|---|---|---|
| Green fodder: | *Pounds* | *Pounds* | *Pounds* | *Pounds* | *Calories* |
| Corn fodder [2] (average of all varieties) | 20.7 | 1.10 | 12.08 | 0.37 | 26,076 |
| Kafir-corn fodder | 27.0 | 0.87 | 13.80 | 0.43 | 29,101 |
| Rye fodder | 23.4 | 2.05 | 14.11 | 0.44 | 31,914 |
| Oat fodder | 37.8 | 2.44 | 17.99 | 0.97 | 42,093 |
| Redtop, in bloom | 34.7 | 2.06 | 21.24 | 0.58 | 45,785 |
| Orchard grass, in bloom | 27.0 | 1.91 | 15.91 | 0.58 | 35,593 |
| Meadow fescue, in bloom | 30.1 | 1.49 | 16.78 | 0.42 | 35,755 |
| Timothy,[3] at different stages | 38.4 | 2.01 | 21.22 | 0.64 | 45,909 |
| Kentucky blue grass | 34.9 | 2.66 | 17.78 | 0.69 | 40,930 |
| Hungarian grass | 28.9 | 1.92 | 15.63 | 0.36 | 34,162 |
| Red clover, at different stages | 29.2 | 3.07 | 14.82 | 0.69 | 36,187 |
| Crimson clover | 19.3 | 2.16 | 9.31 | 0.44 | 23,191 |
| Alfalfa,[4] at different stages | 28.2 | 3.89 | 11.20 | 0.41 | 29,798 |
| Cowpea | 16.4 | 1.68 | 8.08 | 0.25 | 19,209 |
| Soy bean | 28.5 | 2.79 | 11.82 | 0.63 | 29,833 |
| Rape | 14.3 | 2.16 | 8.65 | 0.32 | 21,457 |
| Corn silage (recent analyses) | 25.6 | 1.21 | 14.56 | 0.88 | 33,046 |
| Corn fodder,[2] field cured | 57.8 | 2.34 | 32.34 | 1.15 | 69,358 |
| Corn stover, field cured | 59.5 | 1.98 | 33.16 | 0.57 | 67,766 |
| Kafir-corn stover, field cured | 80.8 | 1.82 | 41.42 | 0.98 | 84,562 |
| Hay from: | | | | | |
| Barley | 89.4 | 5.11 | 35.94 | 1.55 | 82,894 |
| Oats | 84.0 | 4.07 | 33.35 | 1.67 | 76,649 |
| Orchard grass | 90.1 | 4.78 | 41.99 | 1.40 | 92,900 |
| Redtop | 91.1 | 4.82 | 46.83 | 0.95 | 100,078 |
| Timothy [3] (all analyses) | 86.8 | 2.89 | 43.72 | 1.43 | 92,729 |
| Kentucky blue grass | 78.8 | 4.76 | 37.46 | 1.99 | 86,927 |
| Hungarian grass | 92.3 | 4.50 | 51.67 | 1.34 | 110,131 |
| Meadow fescue | 81.0 | 4.20 | 43.34 | 1.73 | 95,725 |
| Mixed grasses | 87.1 | 4.22 | 43.26 | 1.33 | 93,925 |
| Rowen (mixed) | 83.4 | 7.19 | 41.20 | 1.43 | 96,040 |
| Mixed grasses and clover | 87.1 | 6.16 | 42.71 | 1.46 | 97,059 |
| Red clover | 84.7 | 7.38 | 38.15 | 1.81 | 92,324 |
| Alsike clover | 90.3 | 8.15 | 41.70 | 1.36 | 98,460 |
| White clover | 90.3 | 11.46 | 41.82 | 1.48 | 105,346 |
| Crimson clover | 91.4 | 10.49 | 38.13 | 1.29 | 95,877 |
| Alfalfa [4] | 91.6 | 10.58 | 37.33 | 1.38 | 94,936 |
| Cowpea | 89.3 | 10.79 | 38.40 | 1.51 | 97,865 |
| Soy bean | 88.7 | 10.78 | 38.72 | 1.54 | 98,569 |
| Wheatstraw | 90.4 | 0.37 | 36.30 | 0.40 | 69,894 |
| Ryestraw | 92.9 | 0.63 | 40.58 | 0.38 | 78,254 |
| Oat straw | 90.8 | 1.20 | 38.64 | 0.76 | 77,310 |
| Soy-bean straw | 89.9 | 2.30 | 39.98 | 1.03 | 82,987 |

[1] From *Farmers' Bulletin* No. 22 [Revised Edition].

[2] Corn fodder is entire plant, usually sown thick.

[3] Herd's grass of New England and New York.

[4] Lucern.

TABLE V.—*Continued*

| FEEDING STUFF | TOTAL DRY MATTER | PROTEIN | CARBO-HYDRATES | FAT | FUEL VALUE |
|---|---|---|---|---|---|
| | *Pounds* | *Pounds* | *Pounds* | *Pounds* | *Calories* |
| Roots and tubers: | | | | | |
| Potatoes | 21.1 | 1.36 | 16.43 | .... | 33,089 |
| Beets | 13.0 | 1.21 | 8.84 | 0.05 | 18,904 |
| Mangel-wurzels | 9.1 | 1.03 | 5.65 | 0.11 | 12,889 |
| Turnips | 9.5 | 0.81 | 6.46 | 0.11 | 13,986 |
| Ruta-bagas | 11.4 | 0.88 | 7.74 | 0.11 | 16,497 |
| Carrots | 11.4 | 0.81 | 7.83 | 0.22 | 16,999 |
| Grains and other seeds: | | | | | |
| Corn (average of dent and flint) | 81.1 | 7.14 | 66.12 | 4.97 | 157,237 |
| Kafir corn | 87.5 | 5.78 | 53.58 | 1.33 | 116,022 |
| Barley | 89.1 | 8.69 | 64.83 | 1.60 | 143,499 |
| Oats | 89.0 | 9.25 | 48.34 | 4.18 | 124,757 |
| Rye | 88.4 | 9.12 | 69.73 | 1.36 | 152,460 |
| Wheat (all varieties) | 89.5 | 10.23 | 69.21 | 1.68 | 154,848 |
| Cotton seed (whole) | 89.7 | 11.08 | 33.13 | 18.44 | 160,047 |
| Mill products: | | | | | |
| Corn meal | 85.0 | 6.26 | 65.26 | 3.50 | 147,797 |
| Corn-and-cob meal | 84.9 | 4.76 | 60.06 | 2.94 | 132,972 |
| Oatmeal | 92.1 | 11.53 | 52.06 | 5.93 | 143,302 |
| Barley meal | 88.1 | 7.36 | 62.88 | 1.96 | 138,918 |
| Ground corn and oats, equal parts | 88.1 | 7.01 | 61.20 | 3.87 | 143,202 |
| Pea meal | 89.5 | 16.77 | 51.78 | 0.65 | 130,246 |
| Waste products: | | | | | |
| Gluten meal: | | | | | |
| Buffalo | 91.8 | 21.56 | 43.02 | 11.87 | 170,210 |
| Chicago | 90.5 | 33.09 | 39.96 | 4.75 | 155,918 |
| Hammond | 91.9 | 24.90 | 45.72 | 10.16 | 174,228 |
| King | 92.8 | 30.10 | 35.10 | 15.67 | 187,399 |
| Cream gluten (recent analyses) | 90.4 | 30.45 | 45.36 | 2.47 | 151,420 |
| Gluten feed (recent analyses) | 91.9 | 19.95 | 54.22 | 5.35 | 160,533 |
| Buffalo (recent analyses) | 91.0 | 22.88 | 51.71 | 2.89 | 150,933 |
| Rockford (Diamond) | 91.3 | 20.38 | 54.71 | 3.82 | 155,788 |
| Hominy chops | 88.9 | 8.43 | 61.01 | 7.06 | 158,952 |
| Malt sprouts | 89.8 | 18.72 | 43.50 | 1.16 | 120,624 |
| Brewers' grains (wet) | 24.3 | 4.00 | 9.37 | 1.38 | 30,692 |
| Brewers' grains (dried) | 92.0 | 19.04 | 31.79 | 6.03 | 119,990 |
| Distillery grains (dried), principally corn | 93.0 | 21.93 | 38.09 | 10.83 | 157,340 |
| Distillery grains (dried), principally rye | 93.2 | 10.38 | 42.48 | 6.38 | 125,243 |
| Atlas gluten feed (distillery by-product) | 92.6 | 23.23 | 35.64 | 11.88 | 159,818 |
| Rye bran | 88.2 | 11.47 | 52.40 | 1.79 | 126,352 |
| Wheat bran, all analyses | 88.5 | 12.01 | 41.23 | 2.87 | 111,138 |
| Wheat middlings | 84.0 | 12.79 | 53.15 | 3.40 | 136,996 |
| Wheat shorts | 88.2 | 12.22 | 49.98 | 3.83 | 131,855 |
| Buckwheat bran | 88.5 | 19.29 | 31.65 | 4.56 | 113,992 |
| Buckwheat middlings | 88.2 | 22.34 | 36.14 | 6.21 | 134,979 |
| Cotton-seed feed | 92.0 | 9.65 | 38.57 | 3.37 | 103,911 |
| Cotton-seed meal | 91.8 | 37.01 | 16.52 | 12.58 | 152,653 |
| Cotton-seed hulls | 88.9 | 1.05 | 32.21 | 1.89 | 69,839 |
| Linseed meal (old process) | 90.8 | 28.76 | 32.81 | 7.06 | 144,313 |

TABLE V.—*Continued*

| Feeding Stuff | Total Dry Matter | Protein | Carbo-hydrates | Fat | Fuel Value |
|---|---|---|---|---|---|
| Waste products (*cont'd*): | *Pounds* | *Pounds* | *Pounds* | *Pounds* | *Calories* |
| Linseed meal (new process) | 90.1 | 30.59 | 38.72 | 2.90 | 141,155 |
| Sugar-beet pulp (fresh) | 10.1 | 0.63 | 7.12 | .... | 14,415 |
| Sugar-beet pulp (dry) | 93.6 | 6.80 | 65.49 | .... | 134,459 |
| Milk and its by-products: | | | | | |
| Whole milk | 12.8 | 3.38 | 4.80 | 3.70 | 30,829 |
| Skim milk, cream raised by setting | 9.6 | 3.10 | 4.61 | 0.90 | 18,139 |
| Skim milk, cream raised by separator | 9.4 | 3.01 | 5.10 | 0.30 | 16,351 |
| Buttermilk | 9.0 | 2.82 | 4.70 | 0.50 | 16,097 |
| Whey | 6.2 | 0.56 | 5.00 | 0.10 | 10,764 |

## FUEL VALUE

The last column in the above table, headed "fuel value," indicates the heat and energy power of the food. As stated above, one of the primary functions of the food is to produce heat for the body and energy for work. The value of food for this purpose is measured in "heat units" or "calories,"[1] and is calculated from the nutrients digested. Thus the fuel power of 1 pound of digestible fat is estimated to be 4,220 calories, and of 1 pound of digestible portein or carbohy drates about 1,860 calories. The total fuel value of a feeding stuff is found by using these factors.

The meaning of the figures in the above table is that in 100 pounds of green corn fodder containing an average amount of dry matter (20.7 pounds) there are contained approximately 1.10 pounds of digestible protein (materials containing nitrogen), 12.08 pounds of digestible carbohydrates (starch, sugar, fiber, etc.), and 0.37 pound of digestible fat; and that these materials when consumed in the body will yield 26,076 calories of heat, furnishing energy for work and maintaining the temperature of the body.

[1] A calorie of heat is the amount required to raise the temperature of a pound of water about 4° F.

## Table VI.—Rations Actually Fed to Horses and Digestible Nutrient and Energy in Rations

(Calculated on basis of 1,000 pounds live weight)

| Kind of Horses | Weight of Horses | Rations Actually Fed | Nutrients in Ration per 1,000 Pounds Live Weight | | | | Digestible Nutrients in Ration per 1,000 Pounds Live Weight | | | | Energy in Digestible Nutrients |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Protein | Fat | Nitrogen-free Extract[1] | Crude Fiber | Protein | Fat | Nitrogen-free Extract | Crude Fiber | |
| *Army Horses* | *Lbs.* | *Pounds.* | *Lbs.* | *Lbs.* | *Lbs.* | *Lbs.* | *Lbs.* | *Lbs.* | *Lbs.* | *Lbs.* | *Calories.* |
| United States: | | | | | | | | | | | |
| Cavalry | 1,050 | Oats, 12; Hay, 14 | 2.14 | 0.90 | 12.82 | 4.95 | 1.25 | 0.57 | 8.00 | 1.97 | 23,30 |
| Artillery | 1,125 | Oats, 12; Hay, 14 | 2.00 | .84 | 11.96 | 4.62 | 1.16 | .53 | 7.48 | 1.84 | 21,75 |
| Mules | 1,025 | Oats, 9; Hay, 14 | 1.84 | .78 | 11.39 | 4.80 | 1.00 | .48 | 6.88 | 1.94 | 20,25 |
| *Horses with Light Work* | | | | | | | | | | | |
| Driving horse, Wyoming Station | 1,200 | Alfalfa, 21.25; Straw, 3.2 | 2.38 | .18 | 5.87 | 2.34 | 1.76 | .05 | 3.58 | .92 | 11,85 |
| Carriage horse | 1,050 | Oats, 10; Hay, 12 | 2.06 | .76 | 10.42 | 3.87 | 1.40 | .40 | 6.97 | 1.44 | 19,93 |
| Average | | | 2.22 | .47 | 8.15 | 3.10 | 1.58 | .22 | 5.27 | 1.18 | 15,89 |
| Fire company horses: | | | | | | | | | | | |
| Boston, Mass. | 1,400 | Ground grain, 9.38; Hay, 18 | 1.65 | .68 | 9.57 | 4.57 | .87 | .41 | 6.14 | 1.73 | 18,00 |
| Chicago, Ill. | 1,350 | Oats, 4; Hay, 15 | 1.00 | .43 | 6.77 | 3.50 | .42 | .24 | 3.70 | 1.45 | 11,30 |
| Average of 6, including above | | | 1.35 | .56 | 7.95 | 3.20 | .78 | .35 | 4.99 | 1.26 | 14.5 |
| General average for light work | | | 1.57 | .54 | 8.00 | 3.18 | .99 | .32 | 5.06 | 1.24 | 14.8 |
| *Horses with Moderate Work* | | | | | | | | | | | |
| Express horses: | | | | | | | | | | | |
| Richmond, Va., summer | 1,400 | Corn, 4.67; Oats, 5.33; Bran, 0.83; Corn meal, 4.16; Hay, 15 | 1.79 | .78 | 11.78 | 3.64 | .97 | .45 | 8.19 | 1.46 | 21,6 |
| Jersey City, N. J. | 1,325 | Corn, 2; Oats, 19; Bran, 1.5; Hay, 9.5 | 2.45 | 1.03 | 13.45 | 3.57 | 1.66 | 67 | 9.37 | 1.32 | 25,8 |
| Boston, Mass. | 1,325 | Corn, 12; Oats, 5.25; Hay, 20 | 2.38 | 1.04 | 14.96 | 5.32 | 1.28 | .60 | 9.75 | 2.12 | 27,0 |
| Average of 4, including above | | | 2.15 | .93 | 13.27 | 4.13 | 1.26 | .55 | 9.06 | 1.62 | 24,5 |

[1] Nitrogen-free extract consists of the carbohydrates minus the crude fiber, i.e. sugar, starch, and gu

TABLE VII.—POUNDS OF TOTAL DRY MATTER AND DIGESTIBLE INGREDIENTS (PROTEIN AND CARBOHYDRATES, INCLUDING FATS × 2.25) IN VARYING WEIGHTS OF FODDERS AND FEEDS.

(Used by courtesy of Professor J. L. Hills, of the Vermont Experiment Station, modified from *Bulletin* 81.)

| POUNDS OF FODDER | Total Dry Matter | Protein | Carbohydrates, etc. | Total Dry Matter | Protein | Carbohydrates, etc. | Total Dry Matter | Protein | Carbohydrates, etc. | Total Dry Matter | Protein | Carbohydrates, etc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grasses | *Pasture Grass*, [1] 1:4.8 | | | *Timothy Grass*, 1:14.3 | | | *Red Top Grass*, 1:14.6 | | | *Kentucky Blue Grass*, 1:9.2 | | |
| 2½ | 0.5 | 0.06 | 0.3 | 1.0 | 0.04 | 0.5 | 0.9 | 0.03 | 0.5 | 0.9 | 0.05 | 0.5 |
| 5 | 1.0 | 0.12 | 0.6 | 1.9 | 0.08 | 1.1 | 1.7 | 0.07 | 1.0 | 1.8 | 0.10 | 0.9 |
| 10 | 2.0 | 0.23 | 1.1 | 3.8 | 0.15 | 2.1 | 3.5 | 0.13 | 1.9 | 3.5 | 0.20 | 1.8 |
| 15 | 3.0 | 0.35 | 1.7 | 5.8 | 0.23 | 3.2 | 5.2 | 0.20 | 2.9 | 5.2 | 0.30 | 2.7 |
| 20 | 4.0 | 0.46 | 2.2 | 7.7 | 0.30 | 4.3 | 6.9 | 0.26 | 3.8 | 7.0 | 0.40 | 3.7 |
| 25 | 5.0 | 0.58 | 2.8 | 9.6 | 0.38 | 5.4 | 8.7 | 0.33 | 4.8 | 8.7 | 0.50 | 4.7 |
| 30 | 6.0 | 0.69 | 3.3 | 11.5 | 0.45 | 6.4 | 10.4 | 0.39 | 5.7 | 10.5 | 0.60 | 5.5 |
| 35 | 7.0 | 0.81 | 3.9 | 13.4 | 0.53 | 7.5 | 12.1 | 0.46 | 6.7 | 12.2 | 0.70 | 6.4 |
| 40 | 8.0 | 0.92 | 4.4 | 15.4 | 0.60 | 8.6 | 13.9 | 0.52 | 7.6 | 14.0 | 0.80 | 7.3 |
| Grasses and Green Fodders | *Alfalfa*, 1:3.6 | | | *Green Fodder Corn*, 1:11.7 | | | *Sweet Fodder Corn*, 1:11.3 | | | *Green Barley Fodder*, 1:5.7 | | |
| 2½ | 0.5 | 0.10 | 0 4 | 0.5 | 0.03 | 0.3 | 0.5 | 0.03 | 0.3 | 0.6 | 0.06 | 0.3 |
| 5 | 1.0 | 0.20 | 0.7 | 1.0 | 0.06 | 0.6 | 1.0 | 0.06 | 0.7 | 1.2 | 0.12 | 0.7 |
| 10 | 1.9 | 0.41 | 1.4 | 2.1 | 0.11 | 1.3 | 2.1 | 0.12 | 1.4 | 2.5 | 0.24 | 1.4 |
| 15 | 2.9 | 0.61 | 2.2 | 3.1 | 0.17 | 1.9 | 3.1 | 0.18 | 2.1 | 3.7 | 0.36 | 2.1 |
| 20 | 3.9 | 0.81 | 2.9 | 4.1 | 0.22 | 2.6 | 4.2 | 0.24 | 2.7 | 5.0 | 0.48 | 2.7 |
| 25 | 4.8 | 1.02 | 3.6 | 5.2 | 0.28 | 3.2 | 5.2 | 0.30 | 3.4 | 6.2 | 0.60 | 3.4 |
| 30 | 5.8 | 1.23 | 4.4 | 6.2 | 0.33 | 3.9 | 6.3 | 0.36 | 4.1 | 7.4 | 0.72 | 4.1 |
| 35 | 6.8 | 1.44 | 5.1 | 7.2 | 0.39 | 4.5 | 7.3 | 0.42 | 4.8 | 8.7 | 0.84 | 4.8 |
| 40 | 7.7 | 1.64 | 5.8 | 8.3 | 0.44 | 5.2 | 8.4 | 0.48 | 5.4 | 9.9 | 0.96 | 5.4 |
| Green Fodders | *Green Oat Fodder*, 1:8.7 | | | *Green Rye Fodder*, 1:7.2 | | | *Green Hungarian*, 1:8.7 | | | *Oats and Peas*, 1:4.2 | | |
| 2½ | 0.9 | 0.06 | 0.5 | 0.6 | 0.05 | 0.4 | 0.7 | 0.05 | 0.4 | 0.5 | 0.07 | 0.3 |
| 5 | 1.9 | 0.12 | 1.0 | 1.2 | 0.11 | 0.7 | 1.4 | 0.10 | 0.8 | 1.1 | 0.14 | 0.5 |
| 10 | 3.8 | 0.24 | 2.1 | 2.3 | 0.21 | 1.5 | 2.9 | 0.20 | 1.7 | 2.1 | 0.27 | 1.1 |
| 15 | 5.7 | 0.36 | 3.1 | 3.5 | 0.32 | 2.3 | 4.3 | 0.30 | 2 6 | 3.2 | 0.41 | 1.7 |
| 20 | 7.6 | 0.48 | 4.2 | 4.7 | 0.42 | 3.0 | 5.8 | 0.40 | 3.5 | 4.3 | 0.54 | 2.3 |
| 25 | 9.5 | 0.60 | 5.2 | 5.9 | 0.52 | 3.8 | 7.2 | 0.50 | 4.3 | 5.3 | 0.68 | 2.9 |
| 30 | 11.3 | 0.72 | 6.2 | 7.0 | 0.63 | 4.5 | 8.7 | 0.60 | 5.2 | 6.4 | 0.81 | 3.4 |
| 35 | 13.2 | 0.84 | 7.3 | 8.2 | 0.74 | 5.3 | 10.1 | 0.70 | 6.1 | 7.5 | 0.95 | 4.0 |
| 40 | 15.1 | 0.96 | 8.3 | 9.4 | 0.84 | 6.0 | 11.6 | 0.80 | 6.9 | 8.5 | 1.08 | 4.6 |
| Green Fodders | *Barley and Peas*, 1:3.2 | | | *Red Clover (green)*, 1:5.7 | | | *Alsike Clover (green)*, 1:5.3 | | | *Green Clover Rowen*, 1:4.2 | | |
| 2½ | 0.5 | 0.07 | 0.2 | 0.7 | 0.07 | 0.4 | 0.6 | 0.07 | 0.3 | 0.6 | 0.07 | 0.3 |
| 5 | 1.0 | 0.14 | 0.4 | 1.5 | 0.15 | 0.8 | 1.3 | 0.13 | 0.7 | 1.3 | 0.14 | 0.6 |
| 10 | 2.1 | 0.28 | 0.9 | 2.9 | 0.29 | 1.6 | 2.5 | 0.26 | 1.4 | 2.5 | 0.29 | 1.2 |
| 15 | 3.1 | 0.42 | 1.4 | 4.4 | 0.44 | 2.5 | 3.8 | 0.39 | 2.1 | 3.8 | 0.44 | 1.6 |
| 20 | 4.1 | 0.56 | 1.8 | 5.9 | 0.58 | 3.3 | 5.0 | 0.52 | 2.8 | 5.0 | 0.58 | 2.4 |
| 25 | 5.2 | 0.70 | 2.3 | 7.3 | 0.73 | 4.1 | 6.3 | 0.65 | 3.5 | 6.3 | 0.73 | 3.0 |
| 30 | 6.2 | 0.84 | 2.7 | 8.8 | 0.87 | 4.9 | 7.6 | 0.78 | 4.2 | 7.5 | 0.87 | 3.6 |
| 35 | 7.2 | 0.98 | 3.2 | 10.2 | 1.02 | 5.7 | 8.8 | 0.91 | 4.9 | 8.8 | 1.02 | 4.2 |
| 40 | 8.2 | 1.12 | 3.6 | 11.7 | 1.16 | 6.6 | 10.1 | 1.04 | 5.6 | 10.0 | 1.16 | 4.8 |

[1] Numbers 1:4.8, 1:14.3, etc., give the nutritive ratio.

TABLE VII.—*Continued*

| Pounds of Fodder | Total Dry Matter | Protein | Carbohydrates, etc. | Total Dry Matter | Protein | Carbohydrates, etc. | Total Dry Matter | Protein | Carbohydrates, etc. | Total Dry Matter | Protein | Carbohydrates, etc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Silages | *Corn Silage (mature)*, 1:14.8 | | | *Corn Silage (immature)*, 1:14.6 | | | *Corn Stover Silage*, 1:16.6 | | | *Clover Silage*, 1:4.7 | | |
| 2½ | 0.7 | 0.03 | 0.4 | 0.5 | 0.02 | 0.3 | 0 5 | 0.02 | 0.3 | 0.7 | 0.07 | 0.3 |
| 5 | 1.3 | 0.06 | 0.8 | 1.0 | 0.05 | 0.6 | 1.0 | 0.03 | 0.5 | 1.4 | 0.14 | 0.6 |
| 10 | 2.6 | 0.12 | 1.8 | 2.1 | 0.09 | 1.3 | 1.9 | 0.06 | 1.0 | 2.8 | 0.27 | 1.3 |
| 15 | 3.9 | 0.18 | 2.7 | 3.1 | 0.14 | 1.9 | 2.9 | 0.09 | 1.5 | 4.2 | 0.41 | 1.9 |
| 20 | 5.3 | 0.24 | 3.6 | 4.2 | 0.18 | 2.6 | 3.9 | 0.12 | 2.0 | 5.6 | 0.54 | 2.6 |
| 25 | 6.6 | 0.30 | 4.5 | 5.2 | 0.23 | 3.2 | 4.8 | 0.15 | 2.5 | 7.0 | 0.68 | 3.2 |
| 30 | 7.9 | 0.36 | 5.3 | 6.3 | 0.27 | 3.9 | 5.8 | 0.18 | 3.0 | 8.4 | 0.81 | 3.9 |
| 35 | 9.2 | 0.42 | 6.2 | 7.3 | 0.32 | 4.5 | 6.8 | 0.21 | 3.5 | 9.8 | 0.95 | 4.5 |
| 40 | 10.5 | 0.48 | 7.1 | 8.4 | 0.36 | 5.2 | 7.7 | 0.24 | 4.0 | 11.2 | 1.08 | 5.1 |
| Roots | *Potatoes*, 1:17.3 | | | *Beets*, 1:6.5 | | | *Sugar Beets*, 1:6.8 | | | *Carrots*, 1:9.6 | | |
| 2½ | 0.5 | 0.02 | 0.4 | 0.3 | 0.04 | 0.2 | 0.3 | 0.04 | 0.3 | 0.3 | 0.03 | 0.2 |
| 5 | 1.1 | 0.05 | 0.8 | 0.6 | 0.07 | 0.5 | 0.7 | 0.08 | 0.5 | 0.5 | 0.05 | 0.5 |
| 10 | 2.1 | 0.09 | 1.6 | 1.2 | 0.14 | 0.9 | 1.4 | 0.16 | 1.1 | 1.1 | 0.10 | 1.0 |
| 15 | 3.2 | 0.14 | 2.3 | 1.7 | 0.21 | 1.4 | 2.0 | 0.24 | 1.7 | 1.6 | 0.15 | 1.4 |
| 20 | 4.2 | 0.18 | 3.1 | 2.3 | 0.28 | 1.8 | 2.7 | 0.32 | 2.2 | 2.3 | 0.20 | 1.9 |
| 25 | 5.3 | 0.23 | 3.9 | 2.9 | 0.35 | 2.3 | 3.4 | 0.40 | 2.7 | 2.9 | 0.25 | 2.4 |
| 30 | 6.3 | 0.27 | 4.7 | 3.5 | 0.42 | 2.7 | 4.1 | 0.48 | 3.3 | 3 4 | 0.30 | 2.9 |
| 35 | 7.4 | 0.32 | 5.4 | 4.0 | 0.49 | 3 2 | 4.7 | 0.56 | 3.8 | 4.0 | 0.35 | 3.4 |
| 40 | 8.4 | 0.36 | 6.2 | 4.6 | 0.56 | 3.6 | 5.4 | 0.64 | 4.4 | 4.6 | 0.40 | 3.8 |
| Roots and Milk | *Mangel Wurtzels*, 1:4.9 | | | *Ruta-bagas*, 1:8.6 | | | *Turnips*, 1:7.7 | | | *Skimmed Milk* 1:2.0 | | |
| 2½ | 0.2 | 0.03 | 0.1 | 0.3 | 0.03 | 0.2 | 0.2 | 0.03 | 0.2 | 0.2 | 0.07 | 0.1 |
| 5 | 0.4 | 0.06 | 0.3 | 0.5 | 0.05 | 0.4 | 0.5 | 0.05 | 0.4 | 0.5 | 0.15 | 0.3 |
| 10 | 0.9 | 0.11 | 0.5 | 1.1 | 0.10 | 0.9 | 1.0 | 0.10 | 0.8 | 0.9 | 0.29 | 0.6 |
| 15 | 1.4 | 0.17 | 0.8 | 1.6 | 0.15 | 1.3 | 1.4 | 0.15 | 1.2 | 1.4 | 0.44 | 0.9 |
| 20 | 1.8 | 0.22 | 1.1 | 2.3 | 0.20 | 1.7 | 1.9 | 0.20 | 1.5 | 1.9 | 0.58 | 1.2 |
| 25 | 2.3 | 0.28 | 1.4 | 2.9 | 0.25 | 2.2 | 2.4 | 0.25 | 1.9 | 2.4 | 0.73 | 1.6 |
| 30 | 2 7 | 0.33 | 1.6 | 3.4 | 0.30 | 2.6 | 2.9 | 0.30 | 2.3 | 2.8 | 0.87 | 1.8 |
| 35 | 3.2 | 0.39 | 1.9 | 4.0 | 0.35 | 3.0 | 3.3 | 0.35 | 2.7 | 3.2 | 1.02 | 2.1 |
| 40 | 3.6 | 0.44 | 2.2 | 4.6 | 0.40 | 3.4 | 3.8 | 0.40 | 3.1 | 3.7 | 1.16 | 2.4 |
| Milk | *Buttermilk*, 1:1.7 | | | *Whey*, 1:8.7 | | | | | | | | |
| 2½ | 0.2 | 0.10 | 0.2 | 0.2 | 0.02 | 0.1 | | | | | | |
| 5 | 0.5 | 0.19 | 0.3 | 0.3 | 0.03 | 0.3 | | | | | | |
| 10 | 1.0 | 0.38 | 0.6 | 0.6 | 0.06 | 0.5 | | | | | | |
| 15 | 1.5 | 0.57 | 1.0 | 0.9 | 0.09 | 0.8 | | | | | | |
| 20 | 2.0 | 0.76 | 1.3 | 1.2 | 0.12 | 1.0 | | | | | | |
| 25 | 2.5 | 0.95 | 1.6 | 1.5 | 0.15 | 1.3 | | | | | | |
| 30 | 3.0 | 1.14 | 1.9 | 1.9 | 0.18 | 1.6 | | | | | | |
| 35 | 3.5 | 1.33 | 2.2 | 2.2 | 0.21 | 1.8 | | | | | | |
| 40 | 4.0 | 1.52 | 2.6 | 2.5 | 0.24 | 2.1 | | | | | | |

TABLE VII.—*Continued*

| Pounds of Fodder | Total Dry Matter | Protein | Carbohydrates, etc. | Total Dry Matter | Protein | Carbohydrates, etc. | Total Dry Matter | Protein | Carbohydrates, etc. | Total Dry Matter | Protein | Carbohydrates, etc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hays | *Mixed Hay,* 1:10.0 | | | *Timothy Hay,* 1:16.5 | | | *Red Top Hay,* 1:10.3 | | | *Kentucky Blue Grass Hay,* 1:10.6 | | |
| 2½ | 2.1 | 0.11 | 1.1 | 2.2 | 0.07 | 1.2 | 2.3 | 0.12 | 1.2 | 1.9 | 0.09 | 1.0 |
| 5 | 4.2 | 0.22 | 2.2 | 4.3 | 0.14 | 2.3 | 4.6 | 0.24 | 2.4 | 3.7 | 0.19 | 2.0 |
| 7½ | 6.4 | 0.33 | 3.3 | 6.5 | 0.21 | 3.5 | 6.8 | 0.36 | 3.6 | 5.6 | 0.28 | 3.0 |
| 10 | 8.5 | 0.44 | 4.4 | 8.7 | 0.28 | 4.6 | 9.1 | 0.48 | 4.9 | 7.4 | 0.37 | 3.9 |
| 12½ | 10.6 | 0.55 | 5.5 | 10.9 | 0.35 | 5.8 | 11.4 | 0.60 | 6.2 | 9.2 | 0.46 | 4.9 |
| 15 | 12.7 | 0.66 | 6.6 | 13.0 | 0.42 | 6.9 | 13.9 | 0.72 | 7.4 | 11.1 | 0.56 | 5.9 |
| 17½ | 14.8 | 0.77 | 7.7 | 15.2 | 0.49 | 8.1 | 16.0 | 0.84 | 8.6 | 13.0 | 0.65 | 6.9 |
| 20 | 16.9 | 0.88 | 8.8 | 17.4 | 0.56 | 9.2 | 18.2 | 0.96 | 9.8 | 14.8 | 0.74 | 7.9 |
| 25 | 21.2 | 1.10 | 11.0 | 21.7 | 0.70 | 11.6 | 22.8 | 1.20 | 12.3 | 18.5 | 0.93 | 9.9 |
| Hays and Dry Fodder | *Rowen Hay (mixed),* 1:5.6 | | | *Rowen Hay (fine),* 1:4.7 | | | *Alfalfa Hay,* 1:3.8 | | | *Corn Fodder,* 1:14.3 | | |
| 2½ | 2.1 | 0.20 | 1.1 | 2.2 | 0.24 | 1.1 | 2.3 | 0.28 | 1.1 | 1.4 | 0.06 | 0.9 |
| 5 | 4.2 | 0.40 | 2.3 | 4.3 | 0.49 | 2.3 | 4.6 | 0.55 | 2.1 | 2.9 | 0.13 | 1.8 |
| 7½ | 6.3 | 0.60 | 3.4 | 6.5 | 0.73 | 3.4 | 6.9 | 0.83 | 3.2 | 4.3 | 0.19 | 2.7 |
| 10 | 8.3 | 0.80 | 4.5 | 8.7 | 0.97 | 4.6 | 9.2 | 1.10 | 4.2 | 5.8 | 0.25 | 3.6 |
| 12½ | 10.4 | 1.00 | 5.6 | 10.9 | 1.21 | 5.7 | 11.5 | 1.38 | 5.3 | 7.2 | 0.32 | 4.5 |
| 15 | 12.5 | 1.20 | 6.7 | 13.0 | 1.46 | 6.8 | 13.7 | 1.65 | 6.4 | 8.7 | 0.38 | 5.4 |
| 17½ | 14.6 | 1.40 | 7.8 | 15.2 | 1.70 | 8.0 | 16.0 | 1.93 | 7.4 | 10.1 | 0.44 | 6.2 |
| 20 | 16.7 | 1.60 | 8.9 | 17.4 | 1.94 | 9.1 | 18.3 | 2.20 | 8.5 | 11.6 | 0.50 | 7.1 |
| 25 | 20.9 | 2.00 | 11.2 | 21.7 | 2.43 | 11.4 | 22.9 | 2.75 | 10.6 | 14.5 | 0.63 | 8.9 |
| Dry Fodders and Hays | *Corn Stover,* 1:23.6 | | | *Oat Hay,* 1:9.9 | | | *Oat and Pea Hay,* 1:4.9 | | | *Hungarian,* 1:10.0 | | |
| 2½ | 1.5 | 0.04 | 0.8 | 2.3 | 0.10 | 1.0 | 2.2 | 0.28 | 1.2 | 2.1 | 0.12 | 1.2 |
| 5 | 3.0 | 0.07 | 1.7 | 4.6 | 0.21 | 2.0 | 4.4 | 0.56 | 2.3 | 4.2 | 0.25 | 2.4 |
| 7½ | 4.5 | 0.11 | 2.5 | 6.8 | 0.31 | 3.0 | 6.6 | 0.84 | 3.5 | 6.3 | 0.37 | 3.6 |
| 10 | 6.0 | 0.14 | 3.3 | 9.1 | 0.41 | 4.0 | 8.9 | 1.12 | 4.6 | 8.4 | 0.49 | 4.9 |
| 12½ | 7.5 | 0.18 | 4.1 | 11.4 | 0.51 | 5.1 | 11.1 | 1.40 | 5.8 | 10.4 | 0.62 | 6.2 |
| 15 | 9.0 | 0.21 | 5.0 | 13.7 | 0.62 | 6.1 | 13.3 | 1.68 | 6.9 | 12.5 | 0.74 | 7.4 |
| 17½ | 10.5 | 0.25 | 5.8 | 16.0 | 0.72 | 7.1 | 15.5 | 1.96 | 8.1 | 14.6 | 0.86 | 8.6 |
| 20 | 12.0 | 0.28 | 6.6 | 18.2 | 0.82 | 8.1 | 17.7 | 2.24 | 9.2 | 16.7 | 0.98 | 9.8 |
| 25 | 15.0 | 0.35 | 8.3 | 22.8 | 1.03 | 10.2 | 22.1 | 2.80 | 11.6 | 20.9 | 1.23 | 12.3 |
| Hays and Straw | *Red Clover Hay,* 1:5.9 | | | *Alsike Clover Hay,* 1:5.5 | | | *Clover Rowen Hay,* 1:4.9 | | | *Barley Straw,* 1:61.0 | | |
| 2½ | 2.1 | 0.18 | 1.0 | 2.3 | 0.21 | 1.2 | 2.3 | 0.21 | 1.0 | 2.1 | 0.02 | 1.1 |
| 5 | 4.2 | 0.36 | 2.1 | 4.5 | 0.42 | 2.3 | 4.6 | 0.43 | 2.1 | 4.3 | 0.04 | 2.1 |
| 7½ | 6.4 | 0.53 | 3.2 | 6.8 | 0.63 | 3.5 | 6.9 | 0.64 | 3.2 | 6.4 | 0.05 | 3.2 |
| 10 | 8.5 | 0.71 | 4.2 | 9.0 | 0.84 | 4.6 | 9.2 | 0.85 | 4.2 | 8.6 | 0.07 | 4.3 |
| 12½ | 10.6 | 0.89 | 5.2 | 11.3 | 1.05 | 5.8 | 11.5 | 1.07 | 5.2 | 10.7 | 0.09 | 5.3 |
| 15 | 12.7 | 1.07 | 6.3 | 13.5 | 1.26 | 6.9 | 13.8 | 1.28 | 6.3 | 12.9 | 0.11 | 6.4 |
| 17½ | 14.8 | 1.24 | 7.3 | 15.8 | 1.47 | 8.1 | 16.0 | 1.49 | 7.3 | 15.0 | 0.12 | 7.5 |
| 20 | 16.9 | 1.42 | 8.3 | 18.1 | 1.68 | 9.2 | 18.3 | 1.70 | 8.3 | 17.2 | 0.14 | 8.5 |
| 25 | 21.2 | 1.78 | 10.5 | 22.6 | 2.10 | 11.6 | 22.9 | 2.13 | 10.5 | 21.5 | 0.18 | 10.7 |

TABLE VII.—*Continued*

| POUNDS OF FODDER | Total Dry Matter | Protein | Carbohydrates, etc. | Total Dry Matter | Protein | Carbohydrates, etc. | Total Dry Matter | Protein | Carbohydrates, etc. | Total Dry Matter | Protein | Carbohydrates, etc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Straws** | *Oat Straw,* 1:38.3 | | | *Wheat Straw,* 1:93.0 | | | *Rye Straw,* 1:69.0 | | | | | |
| 2½ | 2.3 | 0.03 | 1.2 | 2.3 | 0.01 | 0.9 | 2.3 | 0.02 | 1.0 | .... | .... | .... |
| 5 | 4.6 | 0.06 | 2.3 | 4.5 | 0.02 | 1.9 | 4.6 | 0.03 | 2.1 | .... | .... | .... |
| 7½ | 6.8 | 0.09 | 3.5 | 6.8 | 0.03 | 2.8 | 7.0 | 0.05 | 3.1 | .... | .... | .... |
| 10 | 9.1 | 0.12 | 4.6 | 9.0 | 0.04 | 3.7 | 9.3 | 0.06 | 4.1 | .... | .... | .... |
| 12½ | 11.4 | 0.15 | 5.8 | 11.3 | 0.05 | 4.6 | 11.6 | 0.08 | 5.2 | .... | .... | .... |
| 15 | 13.9 | 0.18 | 6.9 | 13.5 | 0.06 | 5.6 | 13.9 | 0.09 | 6.2 | .... | .... | .... |
| 17½ | 16.0 | 0.21 | 8.1 | 15.8 | 0.07 | 6.5 | 16.3 | 0.11 | 7.2 | .... | .... | .... |
| 20 | 18.2 | 0.24 | 9.2 | 18.1 | 0.08 | 7.4 | 18.6 | 0.12 | 8.3 | .... | .... | .... |
| 25 | 22.7 | 0.30 | 11.5 | 22.6 | 0.10 | 9.3 | 23.2 | 0.15 | 10.4 | .... | .... | .... |
| **Grains** | *Corn Meal,* 1:11.3 | | | *Corn-and-Cob Meal,* 1:13.9 | | | *Oats,* 1:6.2 | | | *Provender* (½ ½). 1:8.4 | | |
| ¼ | 0.2 | 0.02 | 0.2 | 0.2 | 0.01 | 0.2 | 0.2 | 0.02 | 0.1 | 0.2 | 0.02 | 0.2 |
| ½ | 0.4 | 0.03 | 0.4 | 0.4 | 0.02 | 0.3 | 0.4 | 0.05 | 0.3 | 0.4 | 0.04 | 0.3 |
| 1 | 0.9 | 0.06 | 0.7 | 0.9 | 0.05 | 0.7 | 0.9 | 0.09 | 0.6 | 0.9 | 0.08 | 0.6 |
| 2 | 1.7 | 0.13 | 1.4 | 1.7 | 0.10 | 1.3 | 1.8 | 0.18 | 1.1 | 1.7 | 0.15 | 1.3 |
| 3 | 2.6 | 0.19 | 2.1 | 2.6 | 0.14 | 2.0 | 2.7 | 0.28 | 1.7 | 2.6 | 0.23 | 1.9 |
| 4 | 3.4 | 0.25 | 2.9 | 3.4 | 0.19 | 2.7 | 3.6 | 0.37 | 2.3 | 3.5 | 0.31 | 2.6 |
| 5 | 4.3 | 0.32 | 3.6 | 4.3 | 0.24 | 3.4 | 4.5 | 0.46 | 2.8 | 4.4 | 0.39 | 3.2 |
| 7½ | 6.4 | 0.48 | 5.4 | 6.4 | 0.36 | 5.1 | 6.7 | 0.69 | 4.3 | 6.5 | 0.58 | 4.9 |
| 10 | 8.5 | 0.63 | 7.1 | 8.5 | 0.48 | 6.7 | 8.9 | 0.92 | 5.7 | 8.7 | 0.77 | 6.5 |
| **Grains and By-products** | *Provender (as sold in New England),* 1:9.4 | | | *Oat Hulls,* 1:18.2 | | | *Quaker Dairy Feed,* 1:4.6 | | | *H. O. Dairy Feed,* 1:3.3 | | |
| ¼ | 0.2 | 0.02 | 0.2 | 0.2 | 0.01 | 0.1 | 0.2 | 0.03 | 0.1 | 0.2 | 0.04 | 0.1 |
| ½ | 0.4 | 0.03 | 0.3 | 0.5 | 0.02 | 0.3 | 0.5 | 0.05 | 0.3 | 0.5 | 0.07 | 0.2 |
| 1 | 0.9 | 0.07 | 0.6 | 0.9 | 0.03 | 0.5 | 0.9 | 0.11 | 0.5 | 0.9 | 0.15 | 0.5 |
| 2 | 1.8 | 0.14 | 1.3 | 1.9 | 0.05 | 0.9 | 1.8 | 0.22 | 1.0 | 1.8 | 0.29 | 1.0 |
| 3 | 2.7 | 0.20 | 1.9 | 2.8 | 0.08 | 1.4 | 2.8 | 0.33 | 1.5 | 2.7 | 0.44 | 1.5 |
| 4 | 3.5 | 0.27 | 2.5 | 3.7 | 0.10 | 1.9 | 3.7 | 0.44 | 2.0 | 3.6 | 0.59 | 2.0 |
| 5 | 4.4 | 0.34 | 3.2 | 4.6 | 0.13 | 2.4 | 4.6 | 0.55 | 2.5 | 4.6 | 0.74 | 2.5 |
| 7½ | 6.6 | 0.51 | 4.8 | 7.0 | 0.20 | 3.5 | 6.9 | 0.82 | 3.8 | 6.8 | 1.10 | 3.7 |
| 10 | 8.8 | 0.68 | 6.4 | 9.3 | 0.26 | 4.7 | 9.2 | 1.09 | 5.0 | 9.1 | 1.47 | 4.9 |
| **By-products, etc.** | *Victor Corn and Oat Feed,* 1:10.1 | | | *H. O. Horse,* 1:6.4 | | | *Barley,* 1:8.0 | | | *Barley Screenings,* 1:7.7 | | |
| ¼ | 0.2 | 0.02 | 0.2 | 0.2 | 0.02 | 0.1 | 0.2 | 0.02 | 0.2 | 0.2 | 0.02 | 0.2 |
| ½ | 0.5 | 0.03 | 0.3 | 0.5 | 0.05 | 0.3 | 0.4 | 0.04 | 0.3 | 0.4 | 0.04 | 0.3 |
| 1 | 0.9 | 0.06 | 0.6 | 0.9 | 0.09 | 0.6 | 0.9 | 0.09 | 0.7 | 0.9 | 0.09 | 0.7 |
| 2 | 1.8 | 0.13 | 1.3 | 1.8 | 0.18 | 1.2 | 1.8 | 0.17 | 1.4 | 1.8 | 0.17 | 1.3 |
| 3 | 2.7 | 0.19 | 1.9 | 2.7 | 0.28 | 1.8 | 2.7 | 0.26 | 2.1 | 2.6 | 0.26 | 2.0 |
| 4 | 3.6 | 0.25 | 2.5 | 3.6 | 0.37 | 2.4 | 3.6 | 0.35 | 2.8 | 3.5 | 0.34 | 2.7 |
| 5 | 4.5 | 0.32 | 3.2 | 4.5 | 0.46 | 2.9 | 4.5 | 0.44 | 3.5 | 4.4 | 0.43 | 3.3 |
| 7½ | 6.8 | 0.47 | 4.8 | 6.8 | 0.69 | 4.4 | 6.7 | 0.65 | 5.2 | 6.6 | 0.65 | 5.0 |
| 10 | 9.0 | 0.63 | 6.4 | 9.0 | 0.92 | 5.9 | 8.9 | 0.87 | 6.9 | 8.8 | 0.86 | 6.6 |

TABLE VII.—*Continued*

| Pounds of Fodder | Total Dry Matter | Protein | Carbohydrates, etc. | Total Dry Matter | Protein | Carbohydrates, etc. | Total Dry Matter | Protein | Carbohydrates, etc. | Total Dry Matter | Protein | Carbohydrates, etc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| By-products | *Wheat Bran,* 1:3.8 | | | *Wheat Middlings,* 1:4.6 | | | *Wheat Screenings,* 1:5.2 | | | *Mixed (Wheat Feed),* 1:3.9 | | |
| ¼ | 0.2 | 0.03 | 0.1 | 0.2 | 0.03 | 0.1 | 0.2 | 0.02 | 0.1 | 0.2 | 0.03 | 0.1 |
| ½ | 0.4 | 0.06 | 0.2 | 0.4 | 0.06 | 0.3 | 0.4 | 0.05 | 0.2 | 0.4 | 0.07 | 0.3 |
| 1 | 0.9 | 0.12 | 0.5 | 0.9 | 0.13 | 0.6 | 0.9 | 0.10 | 0.5 | 0.9 | 0.13 | 0.5 |
| 2 | 1.8 | 0.24 | 1.0 | 1.8 | 0.25 | 1.2 | 1.8 | 0.20 | 1.0 | 1.8 | 0.27 | 1.0 |
| 3 | 2.6 | 0.36 | 1.4 | 2.6 | 0.38 | 1.7 | 2.7 | 0.29 | 1.5 | 2.7 | 0.40 | 1.5 |
| 4 | 3.5 | 0.48 | 1.8 | 3.5 | 0.50 | 2.3 | 3.5 | 0.39 | 2.0 | 3.6 | 0.53 | 2.1 |
| 5 | 4.4 | 0.60 | 2.3 | 4.4 | 0.63 | 2.9 | 4.4 | 0.49 | 2.5 | 4.5 | 0.67 | 2.6 |
| 7½ | 6.6 | 0.90 | 3.4 | 6.6 | 0.94 | 4.4 | 6.6 | 0.74 | 3.8 | 6.7 | 1.00 | 3.8 |
| 10 | 8.8 | 1.20 | 4.6 | 8.8 | 1.25 | 5.8 | 8.8 | 0.98 | 5.1 | 8.9 | 1.33 | 5.2 |
| By-products, etc. | *Red-dog Flour,* 1:3.3 | | | *Rye,* 1:7.8 | | | *Rye Bran,* 1:5.1 | | | *Cotton-seed Meal,* 1:1.0 | | |
| ¼ | 0.2 | 0.04 | 0.1 | 0.2 | 0.02 | 0.2 | 0.2 | 0.03 | 0.2 | 0.2 | 0.10 | 0.1 |
| ½ | 0.5 | 0.09 | 0.3 | 0.4 | 0.04 | 0.3 | 0.4 | 0.06 | 0.3 | 0.5 | 0.20 | 0.2 |
| 1 | 0.9 | 0.18 | 0.6 | 0.9 | 0.09 | 0.7 | 0.9 | 0.12 | 0.6 | 0.9 | 0.40 | 0.4 |
| 2 | 1.8 | 0.36 | 1.2 | 1.8 | 0.18 | 1.4 | 1.8 | 0.25 | 1.3 | 1.8 | 0.80 | 0.8 |
| 3 | 2.7 | 0.53 | 1.7 | 2.7 | 0.27 | 2.1 | 2.7 | 0.37 | 1.9 | 2.8 | 1.20 | 1.2 |
| 4 | 3.6 | 0.71 | 2.3 | 3.5 | 0.36 | 2.8 | 3.5 | 0.49 | 2.5 | 3.7 | 1.60 | 1.6 |
| 5 | 4.6 | 0.89 | 2.9 | 4.4 | 0.46 | 3 5 | 4.4 | 0.62 | 3.1 | 4.6 | 2.00 | 2.0 |
| 7½ | 6.8 | 1.34 | 4.4 | 6.6 | 0.67 | 5.2 | 6.6 | 0.92 | 4.7 | 6.9 | 3.00 | 3.0 |
| 10 | 9.1 | 1.78 | 5.8 | 8.8 | 0.89 | 6.9 | 8.8 | 1.23 | 6.3 | 9.2 | 4.00 | 4.0 |
| By-products | *Cotton-seed Feed,* 1:5.6 | | | *Cotton-seed Hulls,* .... | | | *Linseed Meal (O. P.),* 1:1.5 | | | *Linseed Meal (N. P.),* 1:1.3 | | |
| ¼ | 0.2 | 0.02 | 0.1 | 0.2 | .... | 0.1 | 0.2 | 0.08 | 0.1 | 0.2 | 0.08 | 0.1 |
| ½ | 0.4 | 0.04 | 0.2 | 0.4 | .... | 0.2 | 0.5 | 0.15 | 0.2 | 0.4 | 0.16 | 0.2 |
| 1 | 0.9 | 0.08 | 0.4 | 0.9 | .... | 0.4 | 0.9 | 0.31 | 0.5 | 0.9 | 0.32 | 0.4 |
| 2 | 1.8 | 0.16 | 0.9 | 1.8 | .... | 0.7 | 1.8 | 0.62 | 1.0 | 1.8 | 0.65 | 0.8 |
| 3 | 2.7 | 0.24 | 1.3 | 2.7 | .... | 1.1 | 2.7 | 0.92 | 1.4 | 2.7 | 0.97 | 1.3 |
| 4 | 3.5 | 0.32 | 1.8 | 3.6 | .... | 1.5 | 3.6 | 1.23 | 1.8 | 3.6 | 1.30 | 1.7 |
| 5 | 4.4 | 0.40 | 2.2 | 4.5 | .... | 1.8 | 4.9 | 1.54 | 2.3 | 4.5 | 1.62 | 2.1 |
| 7½ | 6.6 | 0.59 | 3.3 | 6.7 | .... | 2.7 | 6.8 | 2.31 | 3.4 | 6.7 | 3.43 | 3.2 |
| 10 | 8.8 | 0.79 | 4.4 | 8.9 | .... | 3.7 | 9.0 | 3.08 | 4.6 | 8.9 | 3.24 | 4.2 |
| By-products | *Flax Meal,* 1:1.4 | | | *Gluten Meal (Chicago),* 1:1.5 | | | *Gluten Meal (Cream),* 1:1.7 | | | *Gluten Meal (King),* 1:1.9 | | |
| ¼ | 0.2 | 0.08 | 0.1 | 0.2 | 0.08 | 0.1 | 0.2 | 0.07 | 0.1 | 0.2 | 0.07 | 0.1 |
| ½ | 0.4 | 0.16 | 0.2 | 0.4 | 0.16 | 0.2 | 0.4 | 0.15 | 0.2 | 0.5 | 0.15 | 0.3 |
| 1 | 0.9 | 0.32 | 0.4 | 0.9 | 0.32 | 0.5 | 0.9 | 0.30 | 0.5 | 0.9 | 0.30 | 0.6 |
| 2 | 1.8 | 0.64 | 0.9 | 1.8 | 0.64 | 0.9 | 1.8 | 0.59 | 1.0 | 1.9 | 0.59 | 1.1 |
| 3 | 2.7 | 0.96 | 1.3 | 2.6 | 0.96 | 1.4 | 2.7 | 0.89 | 1.5 | 2.8 | 0.89 | 1.7 |
| 4 | 3.6 | 1.28 | 1.7 | 3.5 | 1.28 | 1.9 | 3.6 | 1.19 | 2.1 | 3.7 | 1.19 | 2.3 |
| 5 | 4.5 | 1.60 | 2.2 | 4.4 | 1.60 | 2.3 | 4.5 | 1.49 | 2.6 | 4.6 | 1.49 | 2.8 |
| 7½ | 6.7 | 2.40 | 3.3 | 6.6 | 2.40 | 3.5 | 6.7 | 2.23 | 3.9 | 6.9 | 2.23 | 4.3 |
| 10 | 8.9 | 3.21 | 4.3 | 8.8 | 3.21 | 4.7 | 9.0 | 2.97 | 5.1 | 9.3 | 2.97 | 5.7 |

TABLE VII.—*Continued*

| Pounds of Fodder | Total Dry Matter | Protein | Carbohydrates, etc. | Total Dry Matter | Protein | Carbohydrates, etc. | Total Dry Matter | Protein | Carbohydrates, etc. | Total Dry Matter | Protein | Carbohydrates, etc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| By-products | *Gluten Feed (Buffalo or Marshalltown)* 1:2.4 | | | *Gluten Feed (Diamond or Rockford)*, 1:3.0 | | | *Hominy Chop*, 1:9.2 | | | *Starch Feed (wet)*, 1:4.9 | | |
| ¼ | 0.2 | 0.06 | 0.1 | 0.2 | 0.05 | 0.2 | 0.2 | 0.02 | 0.2 | 0.1 | 0.01 | 0.1 |
| ½ | 0.4 | 0.12 | 0.3 | 0.5 | 0.10 | 0.3 | 0.5 | 0.04 | 0.4 | 0.2 | 0.03 | 0.2 |
| 1 | 0.9 | 0.23 | 0.6 | 0.9 | 0.20 | 0.6 | 0.9 | 0.09 | 0.8 | 0.3 | 0.05 | 0.3 |
| 2 | 1.8 | 0.47 | 1.1 | 1.8 | 0.41 | 1.2 | 1.8 | 0.17 | 1.6 | 0.7 | 0.11 | 0.5 |
| 3 | 2.7 | 0.70 | 1.7 | 2.7 | 0.61 | 1.9 | 2.8 | 0.26 | 2.4 | 1.0 | 0.16 | 0.8 |
| 4 | 3.6 | 0.93 | 2.3 | 3.6 | 0.81 | 2.5 | 3.7 | 0.35 | 3.2 | 1.4 | 0.22 | 1.1 |
| 5 | 4.5 | 1.17 | 2.8 | 4.6 | 1.02 | 3.1 | 4.6 | 0.44 | 4.0 | 1.7 | 0.27 | 1.3 |
| 7½ | 6.8 | 1.75 | 4.3 | 6.8 | 1.52 | 4.7 | 6.9 | 0.65 | 6.0 | 2.6 | 0.41 | 1.7 |
| 10 | 9.0 | 2.33 | 5.7 | 9.1 | 2.03 | 6.2 | 9.2 | 0.87 | 8.0 | 3.5 | 0.54 | 2.6 |
| By-products | *Dried Brewers' Grains*, 1:3.0 | | | *Atlas Gluten Meal*, 1:2.6 | | | *Malt Sprouts*, 1:2.2 | | | *Pea Meal*, 1:3.2 | | |
| ¼ | 0.2 | 0.04 | 0.1 | 0.2 | 0.06 | 0.2 | 0.2 | 0.05 | 0.1 | 0.2 | 0.04 | 0.1 |
| ½ | 0.5 | 0.08 | 0.3 | 0.5 | 0.12 | 0.3 | 0.4 | 0.09 | 0.2 | 0.4 | 0.08 | 0.3 |
| 1 | 0.9 | 0.16 | 0.5 | 0.9 | 0.25 | 0.6 | 0.9 | 0.19 | 0.4 | 0.9 | 0.17 | 0.5 |
| 2 | 1.8 | 0.31 | 0.9 | 1.8 | 0.49 | 1.3 | 1.8 | 0.37 | 0.8 | 1.8 | 0.33 | 1.1 |
| 3 | 2.8 | 0.47 | 1.4 | 2.8 | 0.74 | 1.9 | 2.7 | 0.56 | 1.2 | 2.7 | 0.50 | 1.6 |
| 4 | 3.7 | 0.63 | 1.9 | 3.7 | 0.98 | 2.6 | 3.6 | 0.74 | 1.6 | 3.6 | 0.67 | 2.1 |
| 5 | 4.6 | 0.79 | 2.4 | 4.6 | 1.23 | 3.2 | 4.5 | 0.93 | 2.0 | 4.5 | 0.84 | 2.7 |
| 7½ | 6.9 | 1.18 | 3.5 | 6.9 | 1.85 | 4.9 | 6.7 | 1.40 | 3.0 | 6.7 | 1.26 | 4.0 |
| 10 | 9.2 | 1.57 | 4.7 | 9.2 | 2.46 | 6.5 | 9.0 | 1.86 | 4.0 | 9.0 | 1.68 | 5.3 |

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(Farmers' Bulletins may be obtained free by application to the Secretary of Agriculture, Washington, D. C.)

### CHAPTER IV

The *World's Work*, August, 1906, p. 7885, "Desert Farming Without Irrigation."

The *World To-day*, August, 1906, p. 862, "Farming Without Water."

## Chapter V

Farmers' Bulletins: No. 192, *Barnyard Manures;* No. 245, *Renovation of Worn-out Soils.*

## Chapter VIII

Farmers' Bulletins: No. 28, *Weeds and How to Kill Them;* No. 27, *Canada Thistle,* Circular 27, Division of Botany; No. 132, *The Insect Enemies of Growing Wheat;* No. 38, *Spraying Fruit;* No. 6, *Bordeaux Mixtures,* Division of Vegetable Pathology; No. 247, *The Control of the Codling Moth and Apple Scab;* No. 19, *Important Insecticides.*

Apply to the Agricultural Experiment Station, Madison, Wis., for the following Farmers' Bulletins: No. 111, *The Prevention of the Oat Smut;* No. 135, *The Spraying of Potatoes.*

## Chapter X

Farmers' Bulletins: No. 157, *The Propagation of Plants;* No. 229, *The Production of Good Seed Corn.*

## Chapter XII

Get seedmen's catalogues and read and study the directions.

Farmers' Bulletins: No. 61, *Asparagus Culture;* No. 154, *The Home Fruit Garden;* No. 94, *The Vegetable Garden;* No. 198, *Strawberries;* No. 220, *Tomatoes;* No. 254, *Cucumbers.*

## Chapter XIII

Farmers' Bulletins: No. 25, *Peanuts;* No. 35, *Potato Culture;* No. 47, *Insects Affecting Cotton;* No. 52, *The Sugar Beet;* No. 81, *Corn Culture in the South;* No. 91, *Potato Diseases;* No. 110, *Rice Culture in the United States;* No. 129, *Sweet Potatoes;* No. 132, *Insect Enemies of Growing Wheat;* No. 199, *Corn Growing.*

### Chapter XIV

Farmers' Bulletins: No. 113, *The Apple and How to Grow It;* No. 33, *Peach Growing for Market;* No. 62, *Marketing Farm Produce;* No. 80, *The Peach-Twig Borer;* No. 175, *Home Manufacture and Use of Unfermented Grape Juice;* No. 203, *Canned Fruits, Preserves, and Jellies.*

### Chapter XV

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Farmers' Bulletins: No. 96, *Raising Sheep for Mutton;* No. 104, *Food Requirements of Pigs,* Agricultural Experiment Station, Madison, Wis. Study them and try to make some experiment suggested by these Bulletins on feeding sheep and pigs.

### Chapter XIX

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